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ABSTRACT

This Missouri Vocational Instruction Management System instructor's drafting guide has been keyed to the drafting competency profile developed by state industry and education professionals. The guide contains a cross-reference table of instructional materials. Four units cover construction techniques pertaining to mathematical calculations: (1) basic math skills; (2) geometric figures and forms; (3) ratio and proportions; and (4) trigonometric functions. Each unit contains the following: (1) unit and specific objectives; (2) suggested activities; (3) instructional materials; (4) unit content; (5) references; (6) instructor notes; (7) information sheets; (8) lessons; (9) transparency masters; (10) handouts; (11) assignment sheets; (12) job sheets; and (13) unit test and answers. (NLA)

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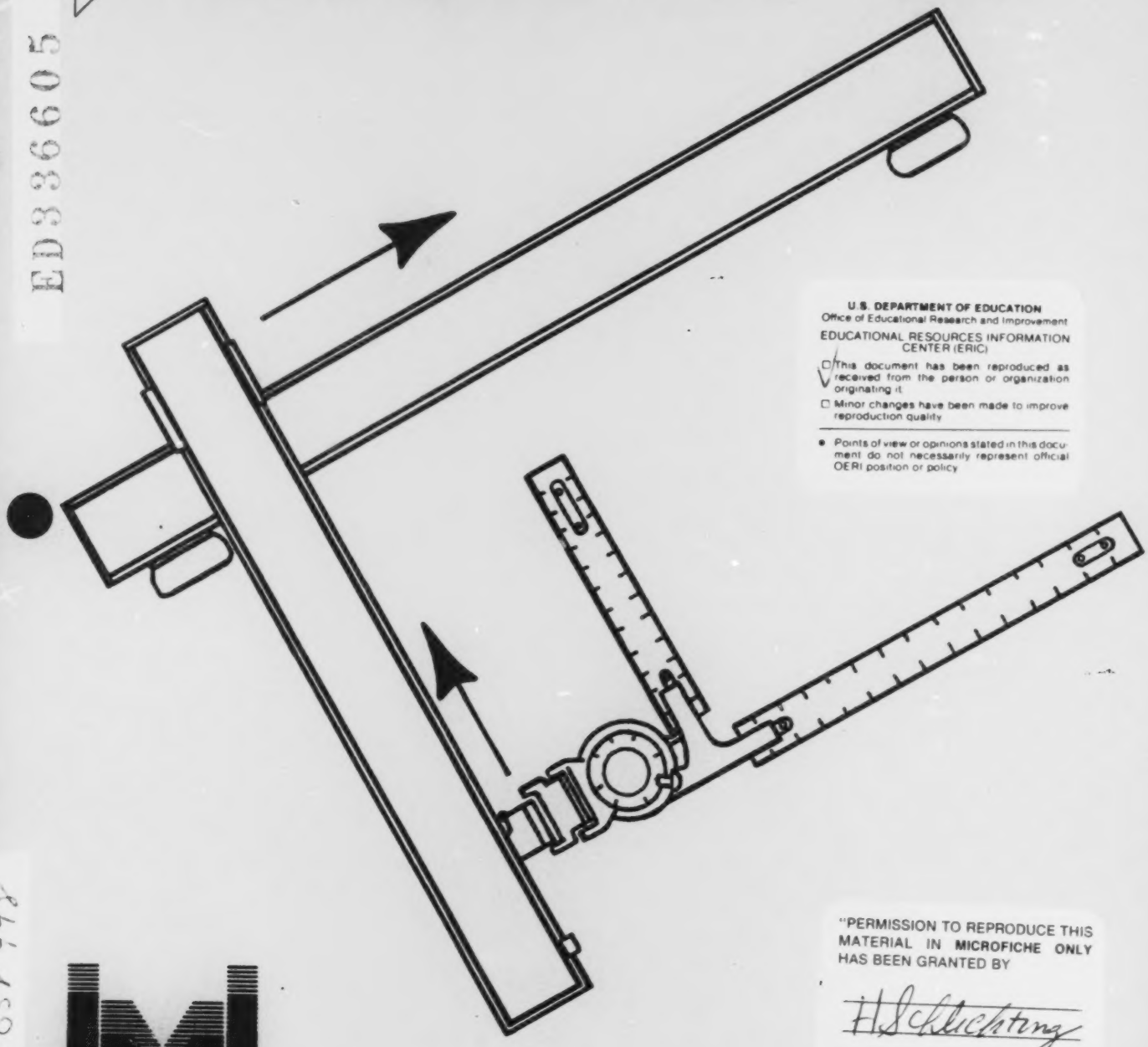
Module

10 PERFORMING MATHEMATICAL CALCULATIONS

70-4010-I
Instructor's Guide

ED336605



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DRAFTING

Module 10: Performing Mathematical Calculations

Instructional Materials Laboratory
8 London Hall
University of Missouri-Columbia
Columbia, MO 65211

1991

Instructor's Guide
Catalog N. 70-4010-I

FORWARD

Once again, we are indebted to the teachers and administrators who provided their time, effort and professionalism to develop curriculum guides for trade, technical and industrial education programs. This drafting guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignments sheets and test items are keyed to specific competencies. A cross-reference table has been included to identify quickly the parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future drafting curriculum modifications will begin with this guide. The drafting field is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding ares for improvement are both encouraged and appreciated.

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ACKNOWLEDGEMENTS

This drafting guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the drafting competency profile developed by industry and education professionals in the state.

When searching for current drafting materials to adopt or use in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these drafting materials.

Special appreciation is given to the writers for their self-motivation, reliability and technical expertise.

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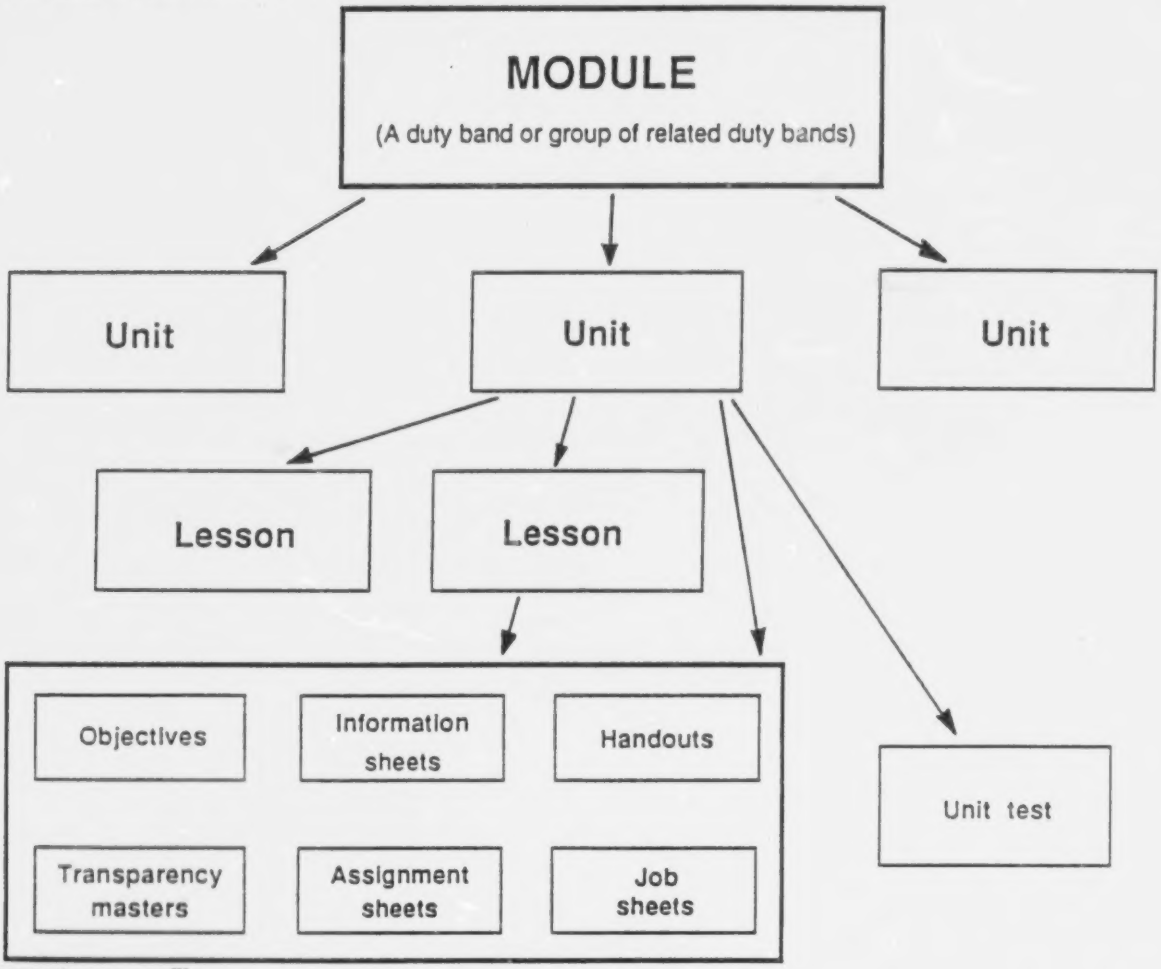
GUIDE COMPONENTS

Units of instruction

This Drafting guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc., are included in the Notes to the Instructor section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

3 = Mastery - can work independently with no supervision
2 = Requires supervision - can perform job completely with limited supervision
1 = Not mastered - requires instruction and close supervision
N = No exposure - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, etc. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives that state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc., are included in the Notes to the Instructor section.

Information sheets (color-coded green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters are noted in the information sheets for instructional use.

Transparency masters (color-coded white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary, and they direct students to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (color-coded white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (color-coded tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (color-coded blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance that might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (color-coded yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), using Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson by lesson.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Drafting guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all ten modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

Drafting

Module: Performing Mathematical Calculations

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
H-5	I	2.1, 2.2		2.1	2.1			
S-1	I	1.1 - 2.2		1.1 - 2.1	1.1, 2.1		1-26	
S-2	II	1.1 - 2-8	1.1 - 2.5		1.1 - 2.3		1-57	
S-2	III	1.1 - 1.3			1.1		1-10	
S-3	IV	1.1 - 1.6		1.1, 1.2	1.1 - 1.3		1-19	

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify mathematical terms and to do calculations using whole numbers, fractions and decimals. The student should also be able to make conversions between English and metric measuring systems. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring ___ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match terms and definitions concerning decimals.

1.2 Determine and interpret decimal equivalents.

1.3 Perform arithmetic operations using decimals.

2.1 Describe and make conversions within English and metric measuring systems.

2.2 Perform conversions between measuring systems.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Pretest
2. Answers to pretest
3. Lesson 1: DECIMALS AND FRACTIONS
   - a. Information outline
   - b. Handouts

     HO 1.1: Decimal equivalents
     HO 1.2: Decimals of a Foot for Each 32nd of an Inch
   - c. Assignment sheet

     AS 1.1: Decimals
   - d. Answers to assignment sheet
4. Lesson 2: MEASUREMENT SYSTEMS AND CONVERSIONS
   - a. Information outline
   - b. Handout

     HO 2.1: English-metric conversion chart
   - c. Assignment sheet

     AS 2.1: Measurement conversions
   - d. Answers to assignment sheet

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

2. Boyce, John G., Samuel Slade and Louis Margolis. Mathematics for Technical and Vocational Schools. 6th ed. New York: Wiley and Sons, Inc., 1975.

3. Cleaves, Cheryl, Margie Hobbs, and Paul Dudenhefer. Basic Mathematics for Trades and Technologies. Englewood Cliffs, NJ: Prentice Hall, 1990.

4. Hoffman, Edward G., and Dennis D. Davis. Practical Problems in Mathematics for Machinists. 3rd ed. Albany, NY: Delmar Publishers, Inc., 1988.

5. McCarthy, Willard J., and Victor E. Repp. Machine Tool Technology. Bloomington, IL: McKnight Publishing, Co., 1984.

B. Curriculum guide

1. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1979.

C. Audiovisuals

1. Machine Shop Math (videotext, Machine Trades series). Edina, MN: Video Training Resource, Inc., 1980.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Instead of information sheets covering basic addition, subtraction, multiplication, division and fractions, a pretest has been included before Lesson 1 to assist in determining which students need remedial math assistance. Students who complete the pretest to a specified level may progress to the assignment sheets. Those who do not pass should work through exercises in an approved math textbook.

2. When discussing the metric system, it is helpful for students to visualize the unit values. This can be accomplished by having metric measuring tools available for measurement of common objects.

3. This unit contains conversion chart handouts that can be used with the assignment sheets and tests if the instructor chooses.

4. It is assumed that the student has mastered the use of a calculator. The student should be encouraged to use a calculator to solve the problems in this unit.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

PRETEST

Choose the letter which corresponds to the correct answer. If your instructor desires, show all calculations on a separate piece of paper.

1. What is the combined weight of four machines weighing 2,354 lbs., 1,952 lbs., 450 lbs. and 4,871 lbs.?

   (a) 2,407 lbs. (b) 7, 427 lbs. (c) 9,627 lbs.
   (d) 9,817 lbs. (e) 13,677 lbs.

2. Five pieces of steel bar measuring 35 mm, 102 mm, 180 mm, 621 mm and 63 mm are cut from a two-meter (2,000 mm) bar. Forty (40) mm is wasted in cutting. How many millimeters are left?

   (a) 77 mm (b) 117 mm (c) 157 mm
   (d) 959 mm (e) 1,039 mm

3. A total of 3,647 parts are produced per hour. How many parts are produced in seven hours?

   (a) 3,654 (b) 3,696 (c) 21,287
   (d) 24,922 (e) 25,529

4. Cut a 999 mm bar into 33 equal pieces. How long is each piece?

   (a) 30.273 mm (b) 33.03 mm (c) 111 mm
   (d) 333 mm (e) 329,67 mm

5. If 187,432 pieces were made in eight hours, how many were made per hour?

   (a) 11,056 (b) 20,730 (c) 22,154
   (d) 23,429 (e) 1,499,456

In the answers to the following problems, reduce all resulting fractions to lowest terms.

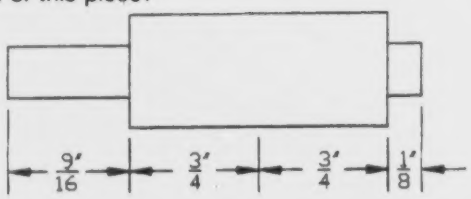
6. 1/2 + 3/4 = _____

   (a) 4/6 (b) 1 1/4 (c) 1 1/6
   (d) 1 1/2 (e) 2/3

7. 3/4 + 5/8 + 9/16 + 5/32 = _____

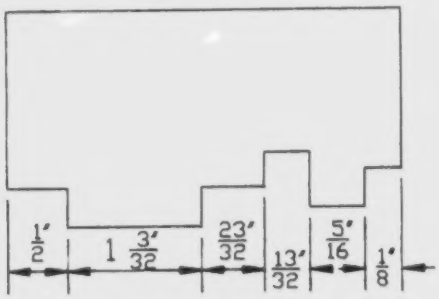
   (a) 11/30 (b) 1 9/16 (c) 2 3/32
   (d) 2 1/4 (e) 2 5/32

8. What is the total length of this piece?



(a) 1/2" (b) 16/35" (c) 1 15/16
(d) 2 3/16" (e) 2 1/4"

9. What is the total length of this profile gauge?



(a) 1 1/2" (b) 1 31/64" (c) 2 2/3"
(d) 3 1/4" (e) 3 5/32"

10. 7/8 - 3/4 = _____

(a) 3/4 (b) 3/5 (c) 1/6
(d) 1/8 (e) 1

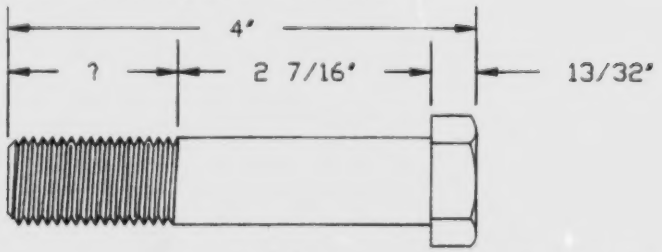
11. 3/8 - 3/32 = _____

(a) 3/4 (b) 9/32 (c) 1/24
(d) 3/20 (e) 1/32

12. 1 9/16 - 3/4 = ___

(a) 13/16 (b) 11/16 (c) 1
(d) 1 3/16 (e) 1 1/2

13. What is the length of the threaded portion of the bolt?



(a) 1/712" (b) 1 5/32" (c) 1 3/8"
(d) 2 1/16" (e) 1 11/32"

14. 5/8 x 3/4 = _____

(a) 3/4 (b) 15/32 (c) 1/2
(d) 1/8 (e) 5/6

15. 5 5/16 x 4 = _____

(a) 6 1/4 (b) 20 5/16 (c) 21 1/4
(d) 22 (e) 22 1/4

16. 17/32 x 30/2 = _____

(a) 51/64 (b) 57/64 (c) 1/28
(d) 7 1/2 (e) 7 31/32

17. 3/4 ÷ 3/8 = _____

(a) 2 (b) 1/2 (c) 3/16
(d) 1/8 (e) 9/32

18. 2 1/2 ÷ 5 = _____

(a) 12 1/2 (b) 2 (c) 1/2
(d) 1/4 (e) 7 1/2

19. 2 7/8 ÷ 3/8 ÷ _____

(a) 1 5/64 (b) 6 1/4 (c) 7 2/3
(d) 8 7/8 (e) 9 1/8

20. How many pieces 3 15/16" long can be cut from a bar 144" long?

(a) 35 (b) 36 (c) 38
(d) 41 (e) 45

21. A screw has 55 threads and the threaded portion is 2 3/4" long. Determine the threads per inch.

(a) 10 (b) 15 (c) 20
(d) 30 (e) 151

Convert the following fractions to decimals.

22. 5/8 = _____

(a) 0.4 (b) 0.725 (c) 0.625
(d) 0.525 (e) 1.3

23. 1/8 = _____

(a) 0.1 (b) 0.125 (c) 0.12
(d) 0.225 (e) 1.1

24. 11/16 = _____

(a) 0.75 (b) 0.7375 (c) 0.6775
(d) 0.6875 (e) 1.3

25. 17/32 = _____

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(a) 0.5312 (b) 0.5734 (c) 0.6512
(d) 1.5 (e) 5.734

26. 57/64 = _____

(a) 0.0932 (b) 0.7214 (c) 0.8906
(d) 0.9231 (e) 1.7

Convert feet and inches to decimal feet.

27. 9' 6 3/4" = _____

(a) 9.25' (b) 9.56' (c) 9.66'
(d) 9.7' (e) 9.634'

28. 3' 4 5/8" = _____

(a) 3.38' (b) 3.28' (c) 2.38
(d) 3.433 (e) 3.385'

29. 14' 2 1/4 = _____

(a) 14.19' (b) 14.18' (c) 14.09
(d) 14.1' (e) 14.225'

Express each decimal as a fraction.

30. 0.8 = _____

(a) 3/4 (b) 8/9 (c) 4/5
(d) 5/6 (e) 1/8

31. 0.7 = _____

(a) 7/100 (b) 17/100 (c) 3/4
(d) 7/10 (e) 7/8

32. 0.375 = _____

(a) 1/3 (b) 3/8 (c) 2/7
(d) 3 3/4 (e) 3/10

Convert decimals to feet and inches.

33. 2.5000' = _____

(a) 2'8" (b) 2'7" (c) 2'6"
(d) 2'5" (e) 250"

ANSWERS TO PRETEST

1. c
2. d
3. e
4. a
5. d
6. b
7. c
8. d
9. e
10. d
11. b
12. a
13. b
14. b
15. c
16. e
17. a
18. c
19. c
20. b
21. c
22. c
23. b
24. d
25. a
26. c
27. b
28. e
29. a
30. c
31. d
32. b
33. c

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

LESSON 1: DECIMALS AND FRACTIONS

I. Terms and definitions

A. **Decimal equivalent**--a way to write fractions to decimals

Examples: 3/4 has a decimal equivalent of 0.75, and the decimal 0.3333 is approximately 1/3.

B. **Decimal fraction**--fractions in which the denominator is 10 or a multiple of 10

C. **Decimal point**--punctuation mark that separates whole numbers from decimals and defines the value of number positions to the right and left of the decimal point

D. **Denominator**--number on the bottom half of a fraction

E. **Difference**--the answer of a subtraction problem

F. **Digit**--one of the symbols of a number system

Examples: 1,2,3,4,5,6,7,8,9

G. **Dividend**--number that is to be divided

H. **Divisor**--the number that is divided into another number

I. **Fraction**--a part of a whole quantity or unit

J. **Improper fraction**--a fraction that has a numerator equal to or larger than its denominator

Examples: 9/3, 2/1, 7/6, 4/4

K. **Lowest terms**--no whole number other than 1 will divide evenly into both the numerator and the denominator of a fraction

L. **Numerator**--number on the top half of a fraction

M. **Mixed number**--a number made up of a whole number and a fraction

Examples: 1 1/2, 3 7/16, 10 1/8

N. **Product**--the answer of a multiplication problem

O. **Proper fraction**--a fraction that has a numerator less than its denominator

P. **Quotient**--the answer of a division problem

Q. **Sum**--the answer of an addition problem

R. **Whole number**--a complete unit where there are no fractional parts left over

II. Reading and determining decimal equivalents

A. Determination

1. Calculated by dividing the numerator by the denominator

2. Can be derived by use of a decimal equivalent chart (HO 1.1)

B. Reading decimals

1. There are the same number of zeros in the denominator of the decimal fraction as there are figures to the right of the decimal point.

Examples:
0.1 is read as one-tenth (1/10)
0.02 is read as two hundredths (2/100)
0.003 is read as three thousandths (3/1000)
0.0004 is read as four ten-thousandths (4/10,000)
0.00005 is read as five hundred-thousandths (5/100,000)
0.000006 is read as six millionths (6/1,000,000)

C. To convert a decimal to a fraction, change it to a common fraction and reduce to its lowest terms or use a conversion table.

III. Operations using decimals

A. Addition and subtraction

1. Write numbers so that all decimal points are in a vertical column. Perform the operation, locating the decimal point in the same vertical column as the others.

B. Multiplication of decimals

1. Multiply the numbers just as for whole numbers.

2. Add the number of decimal places to the right of the decimal points in both of the numbers being multiplied. Starting at the extreme right of the answer, count to the left the total number of decimal places and place the decimal point.

C. Division of decimals

1. Move the decimal point in the divisor to the right until the divisor becomes a whole number. Move the decimal point in the dividend to the right the same number of places. (Add zeros if decimal places in the divisor exceed digits in the dividend.)

2. Locate the decimal point for the answer above the relocated decimal point. Divide to as many places as are required for the answer.

D. Rules for rounding off decimals

1. Check the drawing, sketch or specifications to determine the degree of precision required.

2. When doing calculations, consider the accuracy of each of the figures involved. The answer cannot be more accurate than the least accurate figure used in the calculations.

3. Locate the digit in the decimal place which indicates the required degree of precision.

4. Increase that digit by one if the digit which immediately follows is five or more, dropping all digits that follow.

5. Leave that digit as it is if the digit immediately following is less than five, dropping all digits that follow.

Example: The total of a column of figures is 0.63865. Round off the figure to three places (thousandths). The 6 in the fourth place is greater than five, therefore the third digit is increased by one. The answer stated in three decimal places is: 0.639

DECIMAL EQUIVALENTS

HO 1.1

Fraction	Decimal Equivalent		Fraction	Decimal Equivalent	
	English (in.)	Metric (mm)		English (in.)	Metric (mm)
1/64	0.015625	0.3969	33/64	0.515625	13.0969
1/32	0.03125	0.7938	17/32	0.53125	13.4938
3/64	0.046875	1.1906	35/64	0.546875	13.8906
1/16	0.0625	1.5875	9/16	0.5625	14.2875
5/64	0.078125	1.9844	37.64	0.578125	14.6844
3/32	0.09375	2.3813	19/32	0.59375	15.0813
7/64	0.109375	2.7781	39/64	0.609375	15.4781
1/8	0.1250	3.1750	5/8	0.6250	15.8750
9/64	0.140625	3.5719	41/64	0.640625	16.2719
5/32	0.15625	3.9688	21/32	0.65625	16.6688
11/64	0.171875	4.3656	43/64	0.671875	17.0656
3/16	0.1875	4.7625	11/16	0.6875	17.4625
13/64	0.203125	5.1594	45/64	0.703125	17.8594
7/32	0.21875	5.5563	23/32	0.71875	18.2563
15/64	0.234375	5.9531	47/64	0.734375	18.6531
1/4	0.250	6.3500	3/4	0.750	19.0500
17/64	0.265625	6.7469	49/64	0.765625	19.4469
9/32	0.28125	7.1438	25/32	0.78125	19.8438
19/64	0.296875	7.5406	51/64	0.796875	20.2406
5/16	0.3125	7.9375	13/16	0.8125	20.6375
21/64	0.328125	8.3344	53/64	0.828125	21.0344
11/32	0.34375	8.7313	27/32	0.84375	21.4313
23/64	0.359375	9.1281	55/64	0.859375	21.8281
3/8	0.3750	9.5250	7/8	0.8750	22.2250
25/64	0.390625	9.9219	57/64	0.890625	22.6219
13/32	0.40625	10.3188	29/32	0.90625	23.0188
27/64	0.421875	10.7156	59/64	0.921875	23.4156
7/16	0.4375	11.1125	15/16	0.9375	23.8125
29/64	0.453125	11.5094	61/64	0.953125	24.2094
15/32	0.46875	11.9063	31/32	0.96875	24.6063
31/64	0.484375	12.3031	63/64	0.984375	25.0031
1/2	0.500	12.7000	1	1.000000	25.4000

DECIMALS OF A FOOT
FOR EACH 32ND OF AN INCH

Inch	0	1	2	3	4	5	6	7	8	9	10	11
0	.0	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245
1/8	.0104	.0938	.1771	.2604	.3438	.4271	.5104	.5938	.6771	.7604	.8438	.9271
5/32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8620	.9349
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453
3/8	.0313	.1146	.1979	.2812	.3646	.4479	.5313	.6146	.6979	.7813	.8646	.9479
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8568	.9505
7/16	.0366	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8594	.9531
15/32	.0391	.1224	.2057	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8620	.9557
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714
11/16	.0573	.1406	.2240	.3073	.3908	.4740	.5573	.6406	.7240	.8073	.8906	.9740
23/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
25/32	.0651	.1434	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
27/32	.0703	.1538	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870
7/8	.0729	.1563	.2396	.3229	.4063	.4896	.5729	.6563	.7396	.8229	.9063	.9896
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922
15/16	.0781	.1815	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9974

DECIMALS

Using the chart in HO 1.1, convert the following into decimal equivalents.

1. 1/16 = _____
2. 7/8 = _____
3. 1/2 = _____
4. 1/64 = _____

Using the chart in HO 1.1, convert the following decimal equivalents into fractions.

5. 0.4375 = _____
6. 0.3125 = _____
7. 0.125 = _____
8. 0.6875 = _____

Convert the following feet and inches to decimal feet, rounding off to the fourth decimal place.

9. 9' 6 3/4" = _____
10. 3' 4 5/8" = _____
11. 14' 2 1/4" = _____
12. 1' 6" = _____

Solve the following decimal problems, rounding off to the fourth decimal place.

13. 0.046 + 0.00002 + 0.653 + 8.1673 = _____
14. 0.5 + 0.015 + 0.171 + 8.7003 + 16.37 = _____
15. 8.763 - 1.04 = _____
16. 126.373 - 126.29 = _____
17. 0.9321 x 1.76 = _____
18. 9.429 x 8.670 = _____
19. 0.0672 ÷ 28.5 = _____
20. 73.16 ÷ 24.38 = _____
21. What is the total length of three shafts with the following lengths: 3.165", 8.430" and 2.61"?

22. A machinist milled 0.037" from a 3" thick steel block. What is the thickness of the block when finished?

23. What length of stock is needed to make five 2.125-inch pins (not considering wastage)?

24. How high is a stack of 13 washers if each washer is 0.325" thick?

ANSWERS TO AS 1.1

1.	0.0625	13.	8.8663
2.	0.875	14.	25.7563
3.	0.5	15.	7.723
4.	0.015625	16.	0.083
5.	7/16	17.	1.6405
6.	5/16	18.	81.7494
7.	1/8	19.	0.0024
8.	11/16	20.	3.0008
9.	9.5625'	21.	14.205"
10.	3.3854'	22.	2.963"
11.	14.1875'	23.	10.635"
12.	1.5'	24.	4.225"

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

LESSON 2: MEASUREMENT SYSTEMS AND CONVERSIONS

I. Systems used for measurement

A. The traditional system is the English or U.S. customary system.

1. In order to convert within the system, one must know the relationship between measurements, such as the number of inches per foot and the number of quarts per gallon.

2. English equivalents

<u>Length and area</u>		
1 foot (ft.) (')	=	12 inches (in.) (")
1 yard (yd.)	=	3 feet (ft.) (')
1 mile (mi.)	=	5,280 feet (ft.)
1 square foot	=	144 square inches (sq. in.)
1 acre	=	43,560 square feet (sq. ft.)
<u>Volume measures for fluids</u>		
1 quart (qt.)	=	2 pints (pt.) or 4 cups
1 gallon (gal.)	=	4 quarts (qt.) or 231 cubic inches (cu. in.)
<u>Weight</u>		
1 pound (lb.)	=	16 ounces (oz.)
1 ton	=	2000 pounds in the U.S. (short ton)

3. The basic units of length are the inch and fractions of an inch, such as halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths.

a. Drafters also use inches expressed as decimals, such as thousandths and ten-thousandths of an inch.

4. The basic units of volume used are quarts and gallons.

5. The basic unit of weight or mass is the pound.

B. The metric system is used by scientists everywhere and in most countries in the world.

1. The U.S. manufacturing, measurements are gradually being changed over to metric, which may take a number of years. Many companies have already converted to the metric system.

2. Because it is based on tens, conversion within this measuring system is easier than within the English system.

3. The basic units of length used are the meter (m), centimeter (cm) and millimeter (mm).

4. The basic unit of volume is the liter (l). (one liter = one cubic decimeter)

5. The basic units of weight or mass are the gram (g) and kilogram (kg).

6. Multiples or parts of the basic unit are expressed by adding a prefix.

   a. The prefix "kilo-" means 1000, so 1 kilometer = 1000 meters.

   b. The prefix "deci-" means 1/10, so 1 decimeter = 0.1 meter.

   c. The prefix "centi-" means 1/100--1 centimeter = 0.01 meter.

   d. The prefix "milli-" means 1/1000--1 millimeter = 0.001 meter.

II. Conversions between English and metric measures (HO 2.1)

A. Generally, when working with English units, think in terms of English units. When working in metric units, think in terms of metric units and only convert when necessary.

B. Common conversions

1. One inch equals 25.4 mm (millimeters) or 2.54 cm (centimeters).

   a. To convert inches to millimeters, multiply by 25.4.

   b. To convert millimeters to inches, divide by 25.4.

   c. Other conversions are made in the same way.

2. One meter equals 39.37 inches or slightly more than a yard.

3. One square inch (in^2) equals 6.4516 square centimeters (cm^2) or 645.16 square millimeters (mm^2).

4. One cubic inch (in^3) equals 16.387064 cm^3 or 16387.064 mm^3.

5. One gallon equals 3.785 1 (liters).

6. One kilogram (kg) equals 2.205 pounds.

Measures of Length

1 millimeter (mm)	=	0.03937 inch
1 centimeter (cm)	=	0.39370 inch
1 meter (m)	=	39.37008 inches
	=	3.2808 feet
	=	1.0936 yards
1 kilometer (km)	=	0.5214 mile

1 inch	=	25.4 millimeters (mm)
	=	2.54 centimeters (cm)
1 foot	=	304.8 millimeters (mm)
	=	0.3048 meter (m)
1 yard	=	0.9144 meter (m)
1 mile	=	1.609 kilometers (km)

Measures of Area

1 square millimeter	=	0.00155 square inch
1 square centimeter	=	0.155 square inch
1 square meter	=	10.764 square feet
	=	1.196 square yards
1 square kilometer	=	0.3861 square mile

1 square inch	=	645.2 square millimeters
	=	6.452 square centimeters
1 square foot	=	929 square centimeters
	=	0.0929 square meter
1 square yard	=	0.836 square meter
1 square mile	=	2.5899 square kilometers

Measures of Capacity (Dry)

1 cubic centimeter	=	0.061 cubic inch
1 liter	=	0.0353 cubic foot
	=	61.023 cubic inches
1 cubic meter	=	35.315 cubic feet
	=	1.308 cubic yards

1 cubic inch	=	16.38706 cubic centimeters
1 cubic foot	=	0.02832 cubic meter
	=	28.317 liters
1 cubic yard	=	0.7646 cubic meter

Measures of Capacity (Liquid)

1 liter	=	1.0567 U. S. quarts
	=	0.2642 U. S. gallon
	=	0.2200 Imperial gallon
1 cubic meter	=	264.2 U. S. gallon
	=	219.969 imperial gallons

1 U. S. quart	=	0.946 liter
1 Imperial quart	=	1.136 liters
1 U. S. gallon	=	3.785 liters
1 Imperial gallon	=	4.546 liters

Measures of Weight

1 gram (g)	=	15.432 grains
	=	0.03215 ounce troy
	=	0.03527 ounces avairdupois
1 kilogram (kg)	=	35.274 ounces avairdupois
1000 kilograms (kg)	=	1 metric ton
	=	1.1021 tons of 2000 pounds
	=	0.9842 tons of 2240 pounds

1 ounce avoirdupois	=	28.35 grams (g)
1 ounce troy	=	31.103 grams (g)
1 pound	=	453.6 grams
	=	0.4536 kilogram (kg)
1 ton of 2240 pounds	=	1016 kilograms (kg)
	=	1.016 metric tons
1 grain	=	0.0648 gram (g)
1 metric ton	=	0.9842 ton of 2240 pound
	=	2204.6 pounds

MEASUREMENT CONVERSIONS

1. Express 3 feet 5 3/8 inches as inches.
2. Express each of the following as feet and inches. Express inches to the nearest 64th.
   a. 6.9 feet
   b. 8.7 feet
   c. 2.13 feet
3. How many pints are there in seven gallons?
4. How many millimeters are there in a decimeter?
5. How many centimeters are there in a meter?
6. How many millimeters are there in a meter?
7. How many millimeters are there in a centimeter?
8. How many millimeters are 66.6 centimeters?
9. How many millimeters are 1.05789 meters?
10. Four pieces measuring 1.13 m, 10.4 cm, 369 mm and 378 mm are cut from a steel bar that is two meters in length. Allowing 4.5 mm for waste, how much is left?
11. Convert 1.56 meters to inches (to the nearest 1/64th inch).
12. Convert 63.2 cm to inches (to the nearest 1/64th inch).
13. Convert 56 inches to millimeters.
14. Convert 3.5 feet to centimeters.
15. Convert five millimeters to inches (to the nearest 1/64th inch).
16. A steel bar is 16' long. Convert this length to meters (round off to thousandths place).

ANSWERS TO AS 2.1

1. 41 3/8"
2. a. 6' 10 51/64"
   b. 8' 8 13/32"
   c. 2' 1 9/16"
3. 56
4. 100 mm
5. 100 cm
6. 1000 mm
7. 10 mm
8. 666 mm
9. 1057.89 mm
10. 14.5 mm
11. 61 27/64"
12. 24 7/8"
13. 1422.4 mm
14. 106.68 cm
15. 13/64"
16. 4.877 meters

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT I: BASIC MATH SKILLS

UNIT TEST

Match terms on the right with definitions.

____	1.	Denominator is 10	a.	Improper fraction
____	2.	Multiplication answer	b.	Decimal fraction
____	3.	Number on the bottom of a fraction	c.	Denominator
____	4.	Number on the top of a fraction	d.	Mixed number
____	5.	Has a numerator less than its denominator	e.	Proper fraction
____	6.	The answer of a division problem	ab.	Numerator
____	7.	Numerator equal to or larger than its denominator	ac.	Quotient
			ad.	Product

Using unit handouts where helpful, choose the best answer to each question.

____ 8. Three pieces measuring 5 1/2 inches, 3 7/8 inches and 2 5/64 inches are cut from a 30-inch cast-iron bar. Allowing 1/8 inch for each cut, how much stock is left?

a. 10 3/64 in.
b. 11 3/8 in.
c. 17 63/64 in.
d. 18 11/64 in.
e. 19 13/49 in.

____ 9. The answer to question #8, expressed as a decimal, is _____ .

a. 0.453 in.
b. 10.05 in.
c. 17.98 in.
d. 18.17 in.
e. 19.26 in.

____ 10. What is the length of stock needed to cut five 3.692 inch rods? (Allow 1/8 inch for each cut.)

a. 8.7 in.
b. 13.69 in.
c. 15.7 in.
d. 18.96 in.
e. 31.8 in.

___ 11. Express the answer to question #10 to the nearest 64th inch.

a. 82/64 in.
b. 8 7/64 in.
c. 114/64 in.
d. 15 7/64 in.
e. 18 61/64 in.

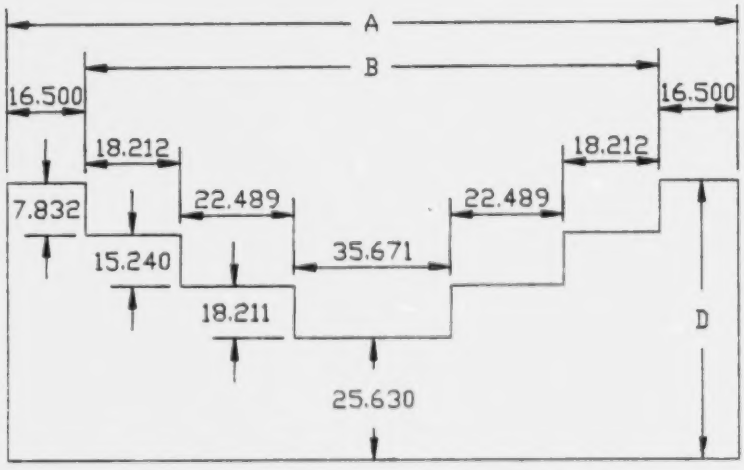
___ 12. 0.00015 is read as _____.

a. 15 ten-thousandths
b. 15 hundred-thousandths
c. 1.5 hundred-thousandths
d. 1.5 thousandths
e. 15 thousandths

___ 13. The decimal equivalent of 6'6 3/4" is _____.

a. 0.675 feet
b. 6.56 feet
c. 6.63 feet
d. 6.67 feet
e. 6.675 inches

Use the drawing of the template below for questions 14-19. Dimensions are given in millimeters.



___ 14. What is dimension A in millimeters?

a. 92.87 mm
b. 117.403 mm
c. 150.073 mm
d. 185.75 mm
e. 195.75 mm

___ 15. What is dimension B in millimeters?

a. 99.3 mm
b. 114.68 mm
c. 117.073 mm
d. 133.57 mm
e. 152.75 mm

___ 16. What is dimension D in millimeters?

a. 30.13 mm
b. 66.913 mm
c. 67.42 mm
d. 82.83 mm
e. 102.52 mm

___ 17. How many templates can be cut from steel stock 70 mm wide and 500 mm long?

a. None
b. 1
c. 2
d. 3
e. 4

___ 18. Convert dimension D to inches.

a. 1.1 in.
b. 2.634 in.
c. 3.282 in.
d. 26.5 in.
e. 32.8 in.

___ 19. Convert dimension D to feet.

a. 0.2195'
b. 0.2634'
c. 0.2735'
d. 0.3282'
e. 13.25'

___ 20. What length of stock is needed to make 25 pins that are 75 mm long? (Allow 2.4 mm wastage per pin.)

a. 63 mm
b. 78.125 mm
c. 1,815 mm
d. 1,935 mm
e. 2,475 mm

___ 21. One inch-diameter rolled steel weights 2.68 pounds per foot of length. How many feet are there in a bundle weighing 189.65 pounds?

a. 63.3'
b. 70.765'
c. 508.262'
d. 707.64'
e. 50,826.2'

___ 22. A centimeter is _____.

a. 1/10 of a meter
b. 1/100 of a meter
c. 10 millimeters
d. 100 decimeters
e. 100 millimeters

___ 23. A decimeter is _____.

a. 1/10 of a meter
b. 1/100 of a meter
c. 10 millimeters
d. 10 meters
e. 100 meters

___ 24. Convert 6.6 inches to millimeters.

a. 0.264 mm
b. 2.598 mm
c. 16.5 mm
d. 167.64 mm
e. 198 mm

___ 25. Decimal equivalent of 12/51 = _____.

a. 0.2351
b. 0.2353
c. 2.353
d. 4.25
e. 12.51

___ 26. 45 in. - 3/64 in. - 9/32 in. - 1/16 in. = _____.

a. 4.2 in.
b. 44.5 in.
c. 44.609 in.
d. 45.391 in.
e. 46.375 in.

ANSWERS TO UNIT TEST

1. b
2. ad
3. c
4. ab
5. e
6. ac
7. a
8. d
9. d
10. d
11. e
12. b
13. b
14. c
15. c
16. b
17. d
18. b
19. a
20. d
21. b
22. b
23. a
24. d
25. b
26. c

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MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT II: GEOMETRIC FIGURES AND FORMS

UNIT OBJECTIVE

After completion of this unit, the student should be able to define, use and apply geometric concepts, formulas, theorems and relationships. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of the lessons in this unit, the student should be able to:

1.1 Match geometric terms with definitions.

1.2 Identify angle measurements.

1.3 Identify angle types.

1.4 Identify and use angle relationship theorems.

2.1 Match terms and definitions concerning figures and geometric relationships.

2.2 Identify and use triangle definitions, formulas and theorems.

2.3 Identify and use quadrilateral definitions, formulas and theorems.

2.4 Identify and use polygon definitions and formulas.

2.5 Identify and use circle definitions, formulas and theorems.

2.6 Determine the surface area and volume of rectangular solids.

2.7 Determine the surface area and volume of cylinders.

2.8 Determine the surface area and volume of spheres.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT II: GEOMETRIC FIGURES AND FORMS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: ANGLES

   a. Information outline

   b. Transparency masters

      TM 1.1: Geometric Shapes
      TM 1.2: Types of Angles

   c. Assignment sheet

      AS 1.1: Angles

   d. Answers to assignment sheet

2. Lesson 2: POLYGONS, CIRCLES AND SOLIDS

   a. Information outline

   b. Transparency Masters

      TM 2.1: Triangles
      TM 2.2: Quadrilaterals
      TM 2.3: Polygons
      TM 2.4: Circular Shapes
      TM 2.5: Circular Shapes Continued

   c. Assignment sheet

      AS 2.1: Polygons
      AS 2.2: Circles
      AS 2.3: Surface Areas and Volumes

   d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

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2. Boyce, John G., Samuel Slade and Louis Margolis. Mathematics for Technical and Vocational Schools. 6th ed. New York: Wiley and Sons, Inc., 1975.

3. Cleaves, Cheryl, Margie Hobbs, and Paul Dudenhefer. Basic Mathematics for Trades and Technologies. Englewood Cliffs, NJ: Prentice Hall, 1990.

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B. Curriculum guides

1. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1977.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. This unit presents formulas and statements which can be applied by drafters. The student is referred to geometry textbooks for the logical basis for these formulas and statements. The instructor may want to explain the proof of one or more of these statements to illustrate geometric interrelationships.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT II: GEOMETRIC FIGURES AND FORMS

LESSON 1: ANGLES

I. Terms and definitions

A. **Angle**--space or form within two lines that come from a common point or within two planes diverging from a common line

B. **Circle**--set of points on a plane which are the same distance from a fixed, central point in the plane

C. **Degree**--defined as 1/360 for a complete rotation, 1/180 of a straight angle or 1/90 of a right angle

D. **Geometric point**--indicator of position. It has no length, width or thickness.

E. **Geometry**--mathematical science which studies space using points, lines and planes

F. **Line**--trace of a moving point (A straight line is the shortest distance between two points.)

G. **Parallel lines**--two straight lines in the same plane which never meet

H. **Perpendicular**--meeting at right angles (90°)

I. **Plane**--flat or level surface which is defined by length and width but has not thickness

J. **Protractor**--tool used to measure angles

II. Angle measurement

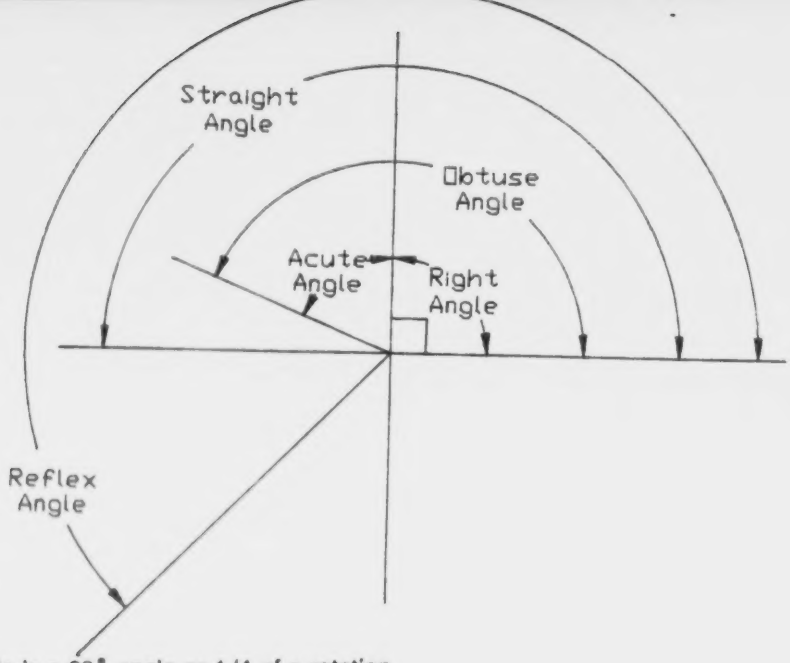
A. One way to think about an angle is to describe it as the amount of rotation of a line when one end of the line is fixed at a point.

B. By definition, a circle or complete rotation contains 360 degrees (360°).

1. Each degree can be divided into 60 minutes (60').

2. Each minute can be divided into 60 seconds (60").

III. Angle types



A. A right angle is a 90° angle or 1/4 of a rotation.

B. An acute angle is one which is less than 90°.

C. An obtuse angle is greater than 90° and less than 180°.

D. A straight angle is 180°.

E. A reflex angle is greater than 180° and less than 360°.

IV. Angle relationships

A. Adjacent angles are angles having one common side.

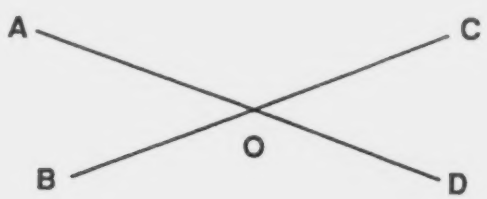
B. Complementary angles are two angles whose sum is a right angle.

C. Supplementary angles are two angles whose sum is a straight angle.

D. The sum of the inside angles of a triangle equal 180°.

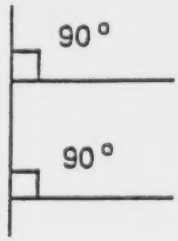
E. The sum of the inside angles of a square equal 360°.

F. When two straight lines intersect, the opposite angles are equal.

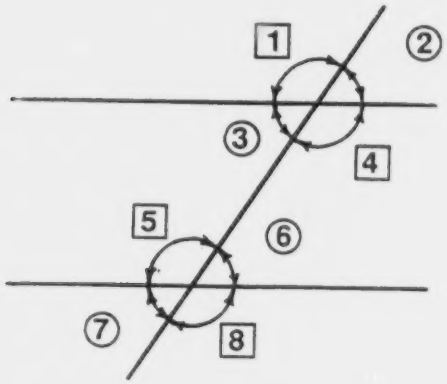


Angle AOB = Angle COD and Angle AOC = Angle BOD
Angle AOB and Angle AOC are adjacent and supplementary angles
Angle BOD and Angle COD are adjacent and supplementary angles

G. If two lines in the same plane form right angles to the same line, they are parallel to each other.



H. If two parallel lines are cut by a third line (called a transversal), the alternate interior angles are equal.



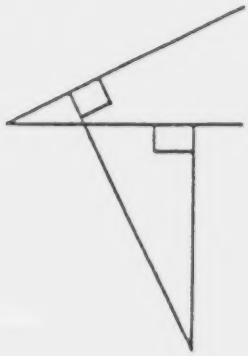
Angle 3 = Angle 6 (Angles 3, 2, 6 and 7 are all equal.)

Angle 5 = Angle 4 (Angles 1, 4, 5 and 8 are all equal.)

Angle 1 + Angle 3 = 180°

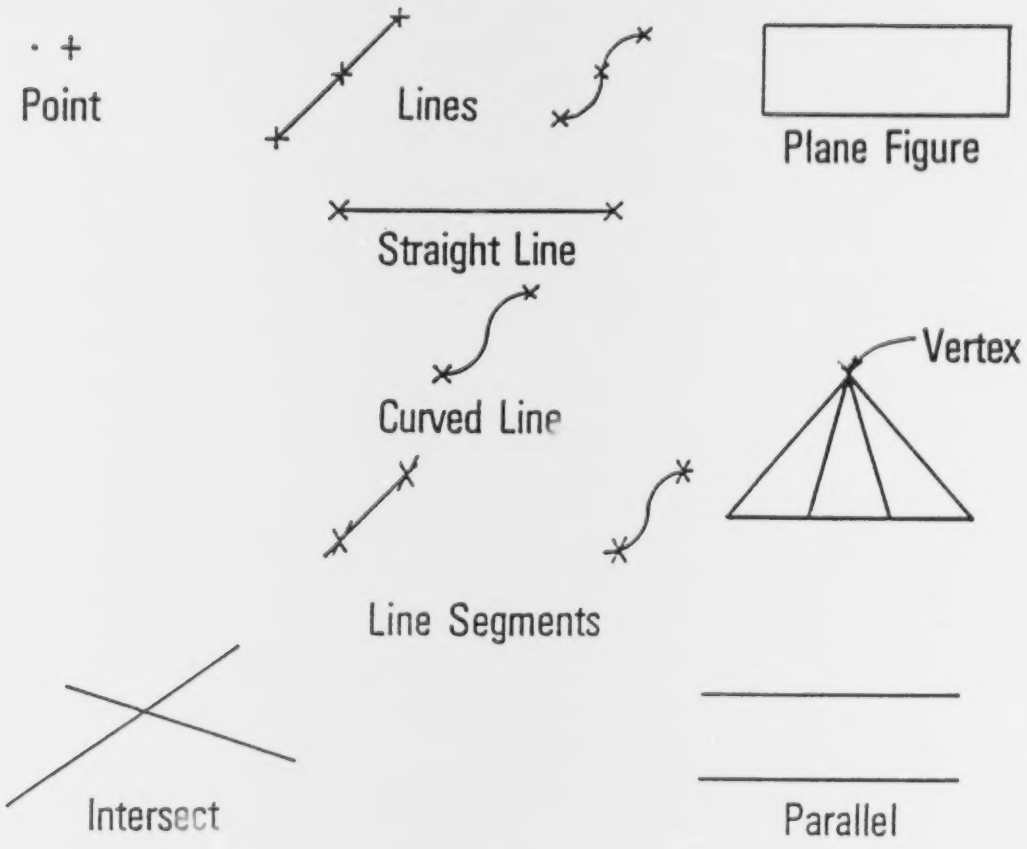
I. If the corresponding sides of angles are parallel, the angles are equal.

J. If the corresponding sides of angles are perpendicular, the angles are equal.

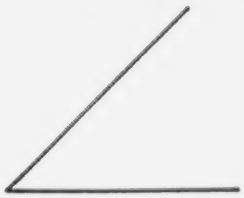


TM 1.1

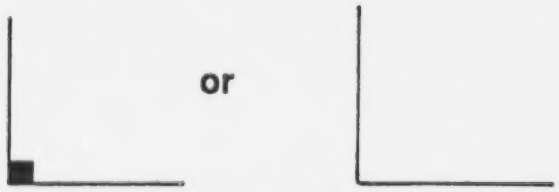
Basic Geometric Shapes and Terms



Types of Angles

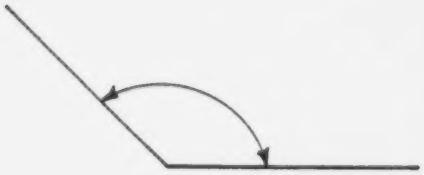


Angle

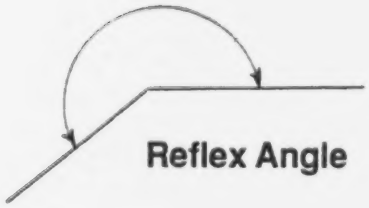


Right Angle

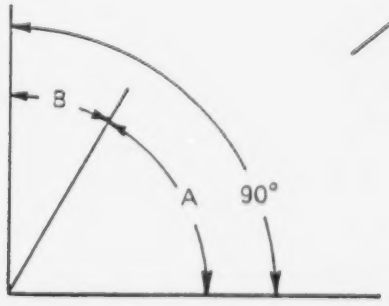
Acute Angle



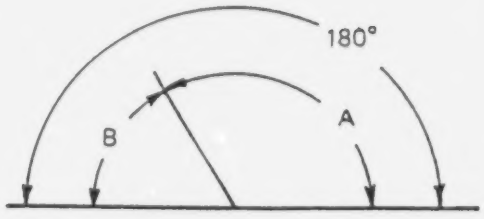
Obtuse Angle



Reflex Angle



Complementary Angles

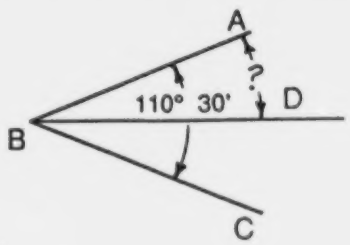


Supplementary Angles

ANGLES

Compute answers to the following problems.

___ 1. If angle ABC is bisected by line BD, what is the angle ABD?

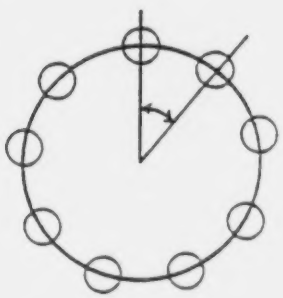


a. 60° 10'
b. 60° 15'
c. 55° 30'
d. 55° 15'

___ 2. What would the bisected angle be of #1 be if angle ABC were 95°?

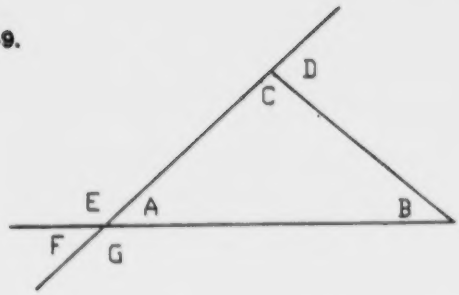
a. 47° 50'
b. 47° 30'
c. 47° 15'
d. 50° 00'

___ 3. A layout of nine holes, equally spaced on a circle, is shown below. What is the angle formed by connecting the centers of adjacent holes with the center?



a. 40°
b. 45°
c. 30°
d. 50°

Use the following triangle for questions 4-9.



ANGLE A= 42°20′ ANGLE B= 40°00′ ANGLE C= 97°20′

____ 4. What type of angle is A?

a. right
b. reflex
c. obtuse
d. acute

____ 5. What type of angle is C?

a. right
b. acute
c. obtuse
d. reflex

____ 6. What type of angle is F?

a. acute
b. right
c. obtuse
d. reflex

____ 7. How many degrees is angle F?

a. 50° 00′
b. 42° 00′
c. 42° 40′
d. not enough information to solve

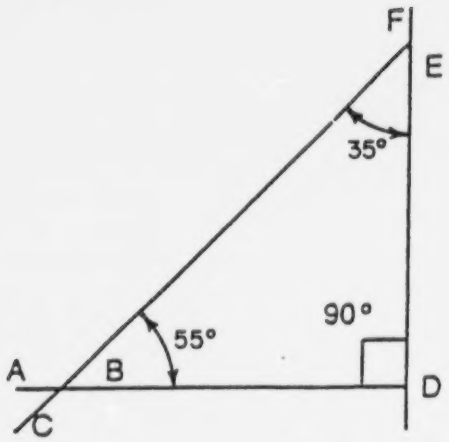
____ 8. How many degrees is angle G?

a. 140° 00′
b. 137° 20′
c. 138° 00′
d. 142° 40′

____ 9. How many degrees do Angle A, Angle E, and Angle F add up to?

a. 182° 40′
b. 220° 00
c. 187° 20′
d. 222° 40′

Use the following triangle for questions 10 - 12.



___10. If angle BED = 35°, what is angle EBA?

a. 115°
b. 125°
c. 120°
d. 130°

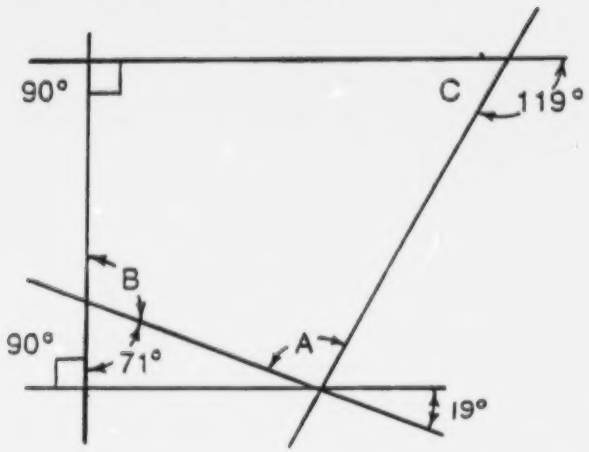
___11. If angle BED = 35°, what is angle ABC?

a. 55°
b. 60°
c. 58°
d. 35°

___12. If angle BED = 35°, what is angle BEF?

a. 150°
b. 140°
c. 135°
d. 145°

Determine the sizes of angles A, B and C in the following illustration.



___13. Angle A

a. 105°
b. 90°
c. 100°
d. 99°

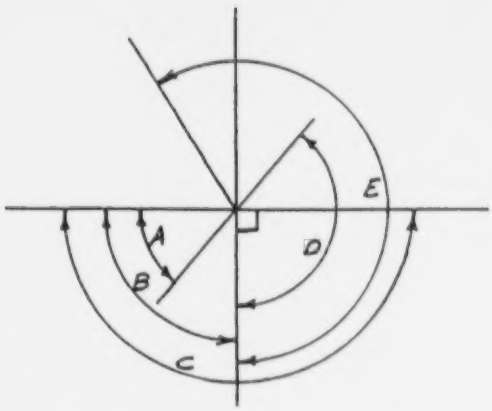
___14. Angle B

a. 109°
b. 119°
c. 115°
d. 110°

___15. Angle C

a. 61°
b. 60°
c. 57°
d. 51°

Matching: Match the angle letter to the correct angle name.



___16. Obtuse

___17. Reflex

___18. Right

___19. Acute

___20. Straight

ANSWERS TO AS 1.1

1. d
2. b
3. a
4. d
5. c
6. a
7. c
8. b
9. d
10. b
11. a
12. d
13. c
14. a
15. a
16. d
17. e
18. b
19. a
20. c

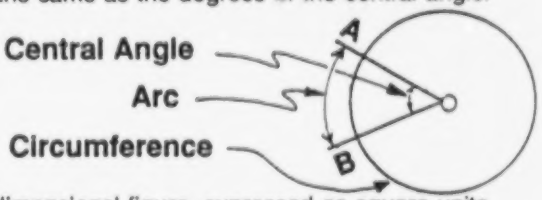
MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT II: GEOMETRIC FIGURES AND FORMS

LESSON 2: POLYGONS, CIRCLES AND SOLIDS

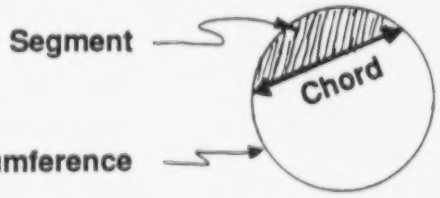
I. Terms and definitions

A. **Arc**--part of a curved line or circle which consists of two end points and the set of points on the circle between them. An arc can be measured by its length (part of the circumference) or by degrees which are the same as the degrees of the central angle.



B. **Area**--space within a boundary in a two-dimensional figure, expressed as square units

C. **Chord**--straight line which connects the two points of an arc or any two points on the circumference of a circle



D. **Circumference**--the length of the curved line which forms a circle

E. **Center**--the point equidistant from the curved line of a circle

F. **Diameter**--chord which passes through the center of a circle, also equal to 2 times the radius (2r)

G. **Equilateral**--sides of equal length

H. **Perimeter**--outer boundary of a two-dimensional figure

I. **Pi (π)**--ratio of a circle's circumference to its diameter. This ratio (approximately 3.1416) is the same for all circles.

J. **Plane geometry**--study of the figures such as the circle, triangle and square that lie in one plane

K. **Radius**--line segment from center of circle to a point on the perimeter of the circle

L. **Polygon**--closed plane figure having three or more straight sides.

M. **Regular polygon**--having equal sides and interior angles.

N. **Solid geometry**--study of figure such as the sphere, cylinder and cube that are three-dimensional and therefore not in one plane

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O. **Semi circle**--one half of a circle

P. **Concentric circles**--circles with a common center.

Q. **Inscribed**--drawn inside of (usually a circle).

R. **Circumscribed**--drawn on the outside of (usually a circle).

S. **Tangents**--lines perpendicular to the radius of the circle at its out extremity.

T. **Segment**--part of the area of a circle bounded by a chord and an arc

U. **Volume**--the amount of space a solid geometric figure occupies, measured as a cubic amount (cubic feet--ft^3)

II. Triangles are three-sided polygons. (TM 2.1)

A. Triangles classified by sides

1. **Scalene triangle**--a triangle with all sides unequal.

2. **Isosceles triangle**--a triangle with two equal sides, and the angles opposite these sides are equal.

3. **Equilateral triangle**--a triangle with all three sides equal. (An equilateral triangle is also equiangular, all angles also equal.

B. Triangles classified by angles

1. **Right triangle**--contains one right (90°) angle.

NOTE: Since the sum of all of the angles in a triangle is 180°, there can be only one right angle in a triangle; the sum of the acute angles of a right triangle is 90°.

2. **Oblique triangle**--a triangle that does not contain a right angle. There are two kinds of oblique triangles:

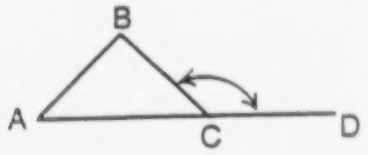
a. **Acute triangle**--each angle is less than 90° (acute angle)

b. **Obtuse triangle**--contains one angle of more than 90° (obtuse angle)

C. Triangle relationships

1. In triangles, angles cannot be changed without changing side lengths. Other polygons do not share this property.

2. The exterior angle formed by extending a line of a triangle is equal to the sum of the opposite interior angles. Angle DCB = Angle CAB + Angle ABC.



3. If two sides and the included angle of one triangle are equal to two sides and the included angle of another, the triangles are identical.

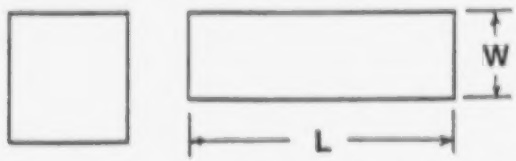
4. If two angles and the included side of one triangle are equal to two angles and the included side of another, the triangles are identical.

C. The perimeter of a triangle is determined by adding together the lengths of all three sides.

D. A triangle's area is determined by the formula: $A = 1/2\ bh$ in which A = area, b = the length of the base and h = height.

III. Quadrilaterals are four-sided polygons. (TM 2.2)

A. Rectangle



1. Rectangles are quadrilaterals in which the opposite sides are parallel and the sides form right angles to each other.

2. Perimeter is determined by the formula: $P = 2L + 2W$ (P = perimeter, L = length and W = width).

3. The area is determined by the formula: $A = L \times W$ in which A = area in square units.

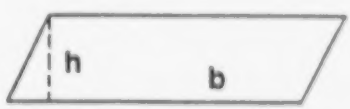
B. Square

1. A square is an equilateral rectangle.

2. Perimeter is determined by the formula: $P = 4L$ in which P = perimeter and L = length of the sides.

3. The area is determined by the formula: $A = L^2$.

C. Parallelogram



1. A parallelogram is a quadrilateral in which opposite sides are parallel but not necessarily perpendicular. (Rectangles and squares are also parallelograms.)

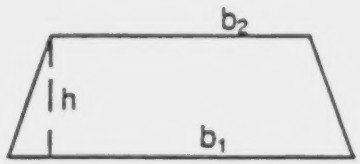
2. Perimeter is determined by the formula: $P = 2L + 2W$ in which P = perimeter, L = length of the longest sides and W = length of the shorter sides.

3. Area is determined by the formula: A = bh in which A = area in square units, b = length of the base and h = height. (Remember that a parallelogram is two triangles, so 2 x [area of both triangles] or 2 [1/2 bh] is the area of the parallelogram.)

4. A rhombus is an equilateral parallelogram.

D. Trapezoid

1. Trapezoids are quadrilaterals in which two sides are parallel and two sides are not.



2. To find perimeter, add together the lengths of all sides.

3. Area is determined by the formula $A = 1/2\ h\ (b_1 + b_2)$ in which A = area in square units, b_1 = length of one of the parallel sides and b_2 = length of the other parallel side.

IV. Other polygons (TM 2.3)

A. Regular polygons are both equilateral and equiangular.

B. The sum of the interior angles of a polygon of n sides is determined by the following formula:

Sum of the angles in degrees = 180 (n-2)

C. Each interior angle of a regular polygon of n sides is determined by the formula:

$$\frac{n-2\ \ 180}{n}$$

D. Polygon names

1. **Pentagon**--five-sided polygon

2. **Hexagon**--six-sided polygon

3. **Heptagon**--seven-sided polygon

4. **Octagon**--eight-sided polygon

5. **Nonagon**--nine-sided polygon

6. **Decagon**--ten-sided polygon

7. **Dodecagon**--twelve-sided polygon

V. Circles (TM 2.4, 2.5)

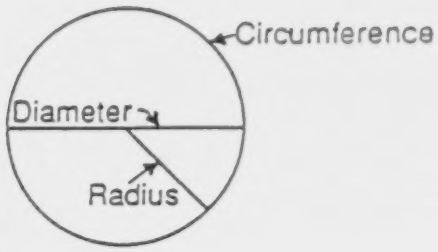
A. The perimeter of a circle is called its circumference.

B. The radius of a circle is the distance between the center to its edge. It is one-half the diameter.

C. A circle's circumference is estimated by the formula $C = \pi D$ or $C = 2\pi r$ (C = circumference, $\pi = 3.1416$ D = diameter, and r = radius).

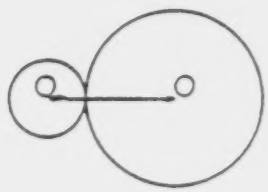
D. The radius or diameter of a circle can be determined by rearranging the circumference formula. $r = C/2\pi$ and $D = C/\pi$

E. A circle's area is determined by the formula $A = \pi r^2$ or $0.7854 (D^2)$ in which A = area in square units, $\pi = 3.1416$, r = radius of the circle and D = diameter of the circle.



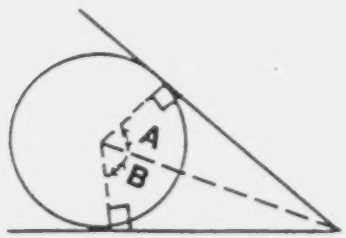
F. Circle relationships

1. If two circles are tangent to each other externally, a line joining the centers will pass through the point of tangency and be equal to the sum of their radii.

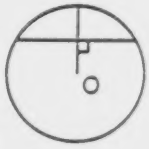


2. If two tangents are drawn from an external point to a circle, the lines are equal in length and a line from the circle's center to this external point forms two equal angles.

Angle A = Angle B

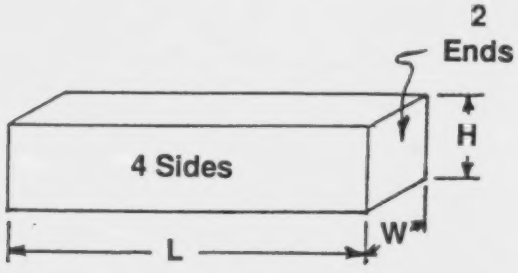


3. A line from the center of a circle that is perpendicular to a chord bisects that chord.



VI. Rectangular solids

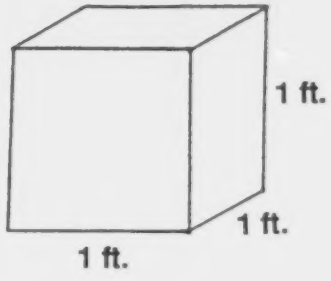
A. The surface area of a rectangular box is determined by adding the areas of the four sides and the two ends together.



B. The volume of a rectangular box is determined by the formula V = L X W X H, in which V = volume expressed as cubic units, L = length, W = width, and H = height.

C. The surface area of a cube is determined by adding the areas of the six equal sides together.

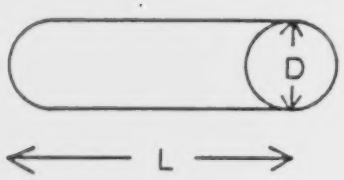
D. The volume of a cube is determined by the formula $V = e^3$, in which V = volume expressed as cubic units, and e = length of one edge.



One cubic foot (1 ft.^{3})

VII. Cylinders (tubes)

A. The outside area of an open cylinder is approximated by the formula $A = \pi DL$ in which A = area in square units, $\pi = 3.1416$, D = diameter and L = length of the tube.



B. The area of a closed cylinder is the area calculated above plus 2 times the area of the ends. Therefore, $A = \pi DL + 2 (.7854D^2)$.

C. The volume of the cylinder is approximated by multiplying the area of the end times the length. ($V = \pi r^2 L$) The answer is expressed as units cubed.

VIII. Spheres

A. A sphere is defined as the set of all points in space at a given distance from a fixed point called the center.

B. The surface area of a sphere is determined by the formula: $A = 4\pi r^2$ where A = surface area, $\pi = 3.14159$, and r = radius.

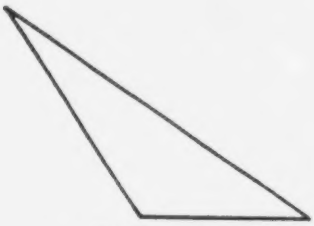
C. The volume of a sphere is approximated by the formula:

$$V = \frac{\pi \times 4 \times r^3}{3}$$

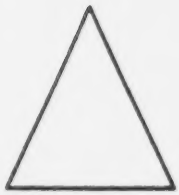
Types of Angles

Triangles classified by sides

Equilateral Triangle

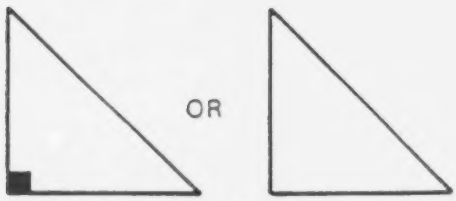


Scalene Triangle



Isosceles Triangle

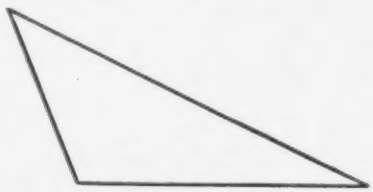
Triangles classified by angles



Right Triangle

Oblique Triangles

Acute Triangle



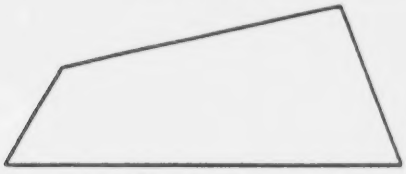
Obtuse Triangle

Quadrilaterals

(TWO SIDES PARALLEL)

Trapezoid

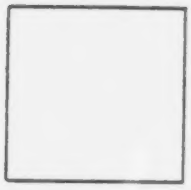
(NO SIDES PARALLEL)



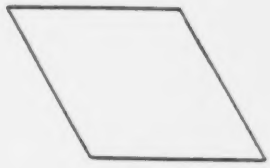
Trapezium

Parallelograms

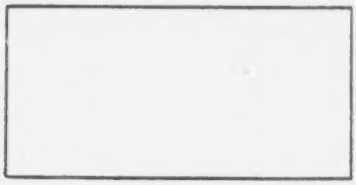
Equilateral Parallelograms



Square



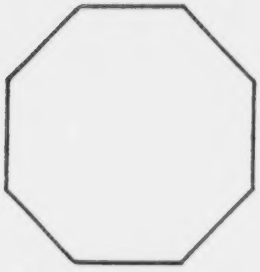
Rhombus



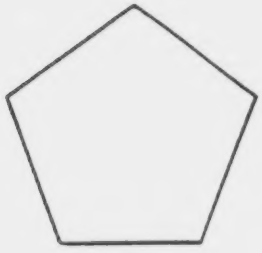
Rectangle

Rhomboid

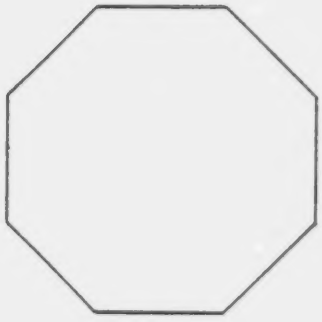
Polygons



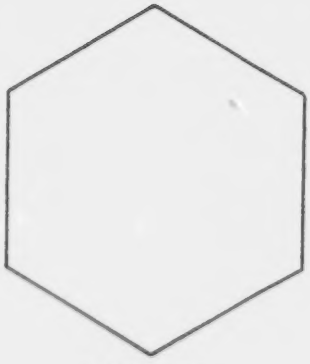
Regular Polygon
All sides & angles equal.



Pentagon

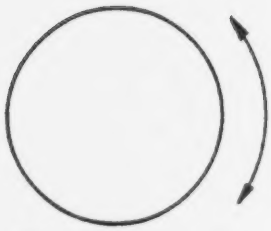


Hexagon

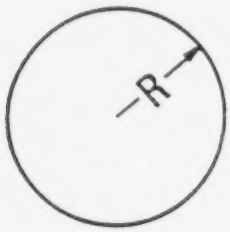


Octagon

Circular Shapes

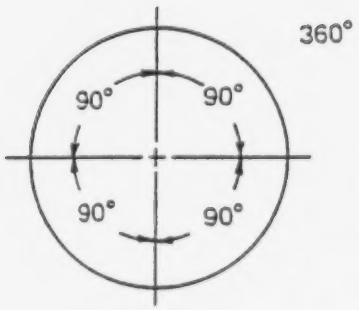


Circumference



Radius

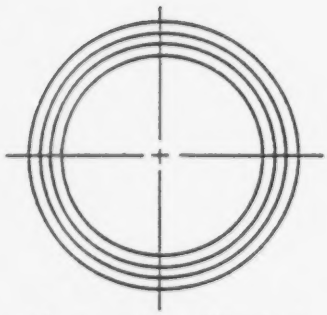
Diameter



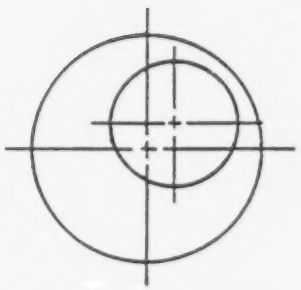
Circle

Arc

Sphere



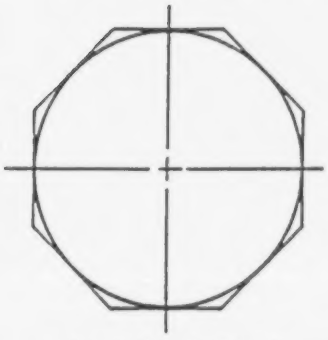
Concentric Circles



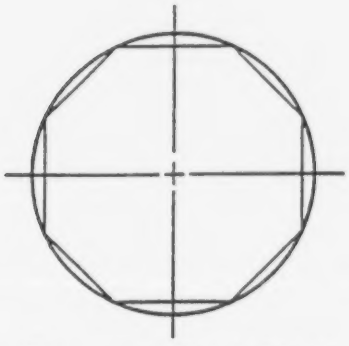
Eccentric Circles

Circular Shapes

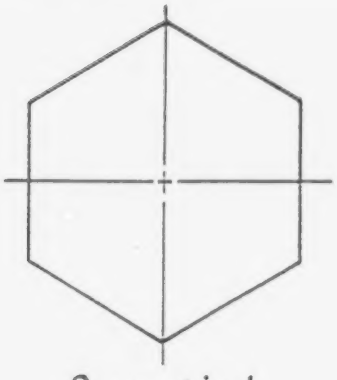
(Continued)



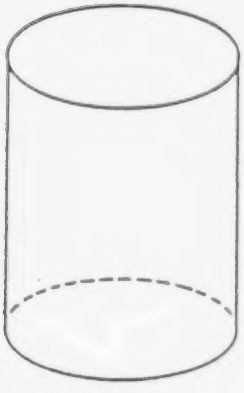
Inscribed Circle



Circumscribed Circle



Symmetrical



Cylinder

PERFORMING MATHEMATICAL CALCULATIONS

POLYGONS

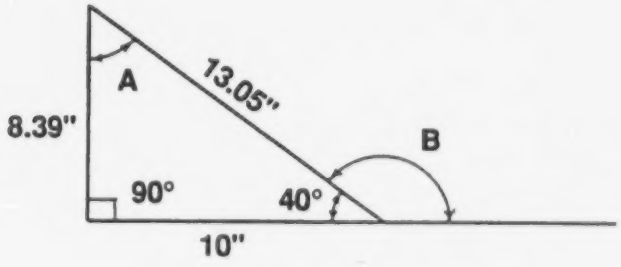
____ 1. What triangle has three equal sides?

a. right
b. oblique
c. acute
d. equilateral

____ 2. What is the total number of degrees in all the interior angles of a square?

a. 90
b. 360
c. 270
d. 180

Use this drawing to answer questions 3 - 7.



____ 3. How many degrees does angle A contain?

a. 40
b. 30
c. 45
d. 50

____ 4. What kind of triangle is the drawing?

a. right
b. equilateral
c. oblique
d. acute

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____ 5. How many degrees does angle B contain?

a. 160°
b. 150°
c. 140°
d. 130°

____ 6. What is the perimeter of the triangle?

a. 18.39"
b. 41.95"
c. 83.90"
d. 31.44"

____ 7. What is the area of the triangle?

a. 83.9 sq. in.
b. 41.95 sq. in.
c. 65.25 sq. in.
d. 54.74 sq. in.

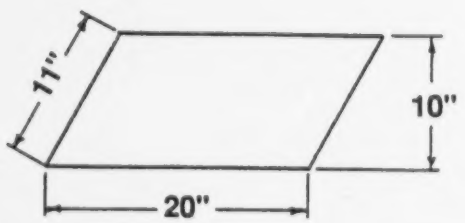
____ 8. Which of the following is <u>not</u> a quadrilateral?

a. triangle
b. square
c. trapezoid
d. rhombus

____ 9. What is the formula for the area of a rectangle?

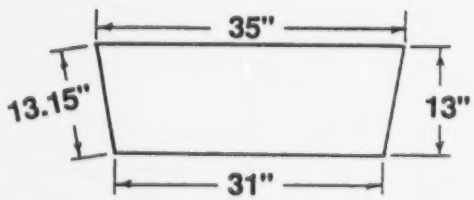
a. A = 1/2bh
b. A = L
c. P = 2L X 2W
d. A = L X W

____10. What is the area for this parallelogram?



a. 200 sq. in.
b. 220 sq. in.
c. 62 sq. in.
d. 100 sq. in.

____11. What is the area for this trapezoid?



a. 495 sq. in.
b. 455 sq. in.
c. 465 sq. in.
d. 429 sq. in.

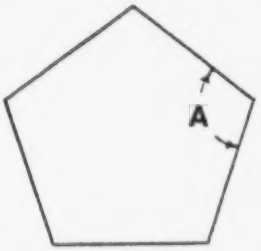
___12. What is the perimeter for the above trapezoid?

a. 92.15"
b. 92.30"
c. 94.30"
d. 92.00"

___13. Which triangle has an angle of more than 90°?

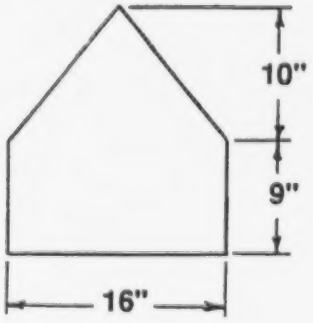
a. right
b. acute
c. obtuse
d. equilateral

___14. All sides of this pentagon are equal. How many degrees is angle A?



a. 100
b. 96
c. 108
d. 82

___15. What is the area of this figure?

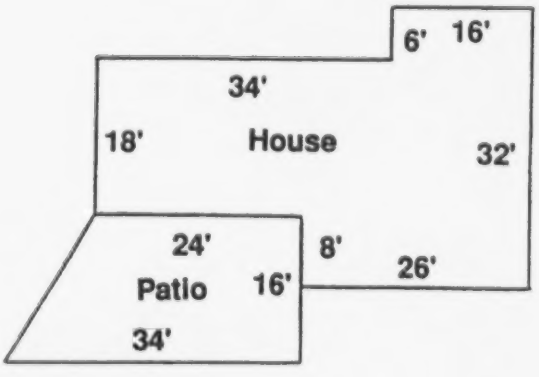


a. 232 sq. in.
b. 228 sq. in.
c. 224 sq. in.
d. 244 sq. in.

___16. How many square feet does this house contain?

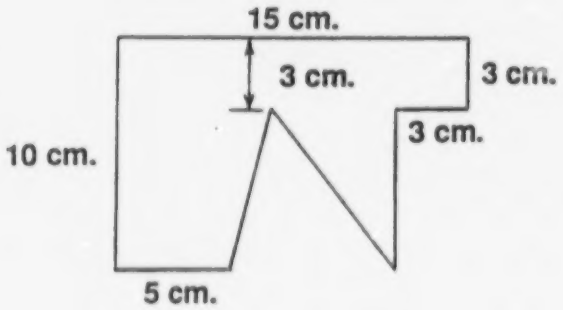
a. 1504
b. 1204
c. 1424
d. 1360

___17. What is the area of the patio?



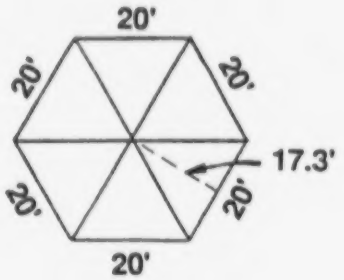
a. 928 sq. ft.
b. 544 sq. ft.
c. 484 sq. ft.
d. 464 sq. ft.

____18. What is the area of this piece of sheet metal?



a. 104.5 sq. cm.
b. 129 sq. cm.
c. 111 sq. cm.
d. 134.5 sq. cm.

____19. What is the area of this polygon?



a. 982 sq. ft.
b. 1200 sq. ft.
c. 1250 sq. ft.
d. 1038 sq. ft.

PERFORMING MATHEMATICAL CALCULATIONS

CIRCLES

___ 1. The symbol π represents the ratio of the diameter to the circumference of a circle. Which number does π represent?

a. 3.1416
b. 314.6
c. 0.7854
d. 7.8540

___ 2. What is the term for the perimeter of a circle?

a. radius
b. diameter
c. area
d. circumference

___ 3. What is the circumference of a circle that has a diameter of 8 in.?

a. 12.5664 in.
b. 50.2656 in.
c. 25.1328 in.
d. 24.3192 in.

___ 4. What is the circumference of a circle that has a radius of 5.75"?

a. 36.1284 in.
b. 18.0642 in.
c. 9.0321 in.
d. 15.3285 in.

___ 5. What is the radius of a circle that has a circumference of 392.7'?

a. 6.25 ft.
b. 62.5 ft.
c. 12.5 ft.
d. 125 ft.

___ 6. A circle has a radius of 6.8". What is the area of the circle?

a. 21.4 sq. in.
b. 581 sq. in.
c. 42.7 sq. in.
d. 145.3 sq. in.

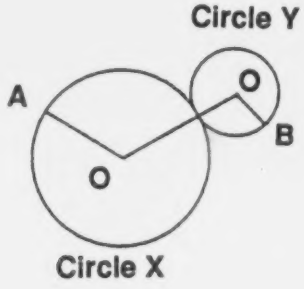
Use this drawing to answer questions 7 - 11.

Circle X is tangent to circle Y.

The center of each circle is shown by point 0.

Line OO is 18 in. long.

Line OB is 6 in. long.



____ 7. How long is line OA?

a. 15 in.
b. 9 in.
c. 18 in.
d. 12 in.

____ 8. What is the diameter of circle X?

a. 22 in.
b. 24 in.
c. 30 in.
d. 18 in.

____ 9. What is the circumference of circle X?

a. 37.7 in.
b. 18 in.
c. 75.4 in.
d. 113.1 in.

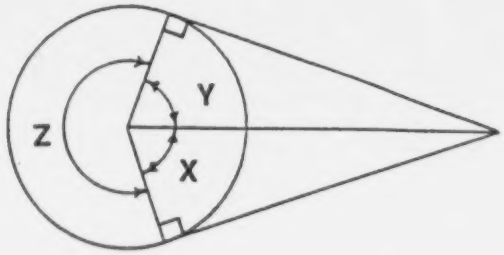
____10. What is the area of circle Y?

a. 113.1 sq. in
b. 37.7 sq. in.
c. 144 sq. in.
d. 18.8 sq. in.

____11. What is the area of circle X?

a. 144 sq. in.
b. 452.4 sq. in.
c. 754 sq. in.
d. 324 sq. in.

Use this drawing to answer questions 12 and 13.



____12. What is angle Y if angle X is 75°?

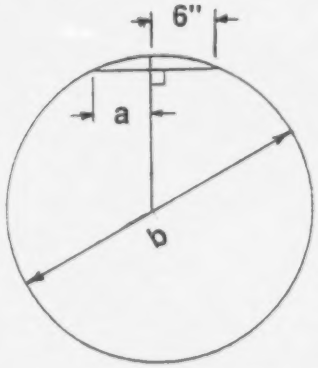
a. 60°
b. 85°
c. 75°
d. not enough information to solve

____13. What is angle Z if angle X is 75°?

a. 210°
b. 180°
c. 230°
d. not enough information to solve

Use this drawing to answer questions 14 and 15.

The circumference is 50.27 in.



____14. What is dimension "a"?

a. 8 in.
b. 7 in.
c. 6 in.
d. 5 in.

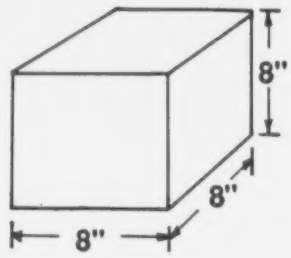
____15. What is dimension "b"?

a. 16 in.
b. 12 in.
c. 14 in.
d. not enough information to solve

PERFORMING MATHEMATICAL CALCULATIONS

SURFACE AREAS AND VOLUMES

Use this drawing to answer questions 1 - 3.



____ 1. What is the volume of this figure?

a. 64 cu. in.
b. 512 cu. in.
c. 128 cu. in.
d. 256 cu. in.

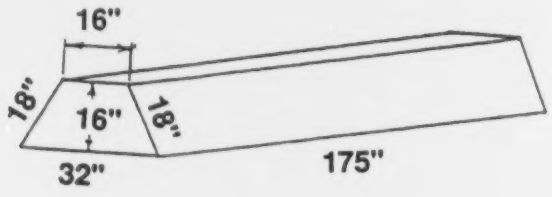
____ 2. What is the surface area of this figure?

a. 384 sq. in.
b. 192 sq. in.
c. 256 sq. in.
d. 64 sq. in.

____ 3. What is the name of this figure?

a. trapezoid
b. rhombus
c. diagonal
d. cube

Use this drawing to answer questions 4 and 5.



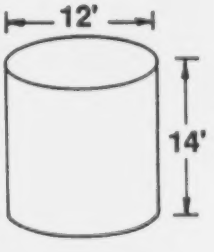
____ 4. What is the surface area of this figure?

a. 17,200 sq. in.
b. 15,468 sq. in.
c. 11,550 sq. in.
d. 12,184 sq. in.

____ 5. What is the volume of this figure?

a. 67,200 cu. in.
b. 50,400 cu. in.
c. 89,600 cu. in.
d. 44,800 cu. in.

Find the surface area and the volume of the following:

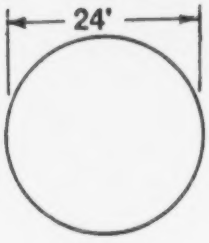


____ 6. Volume

a. 1583.37 cu. ft.
b. 452.39 cu. ft.
c. 527.79 cu. ft.
d. 6333.47 cu. ft.

____ 7. Surface area

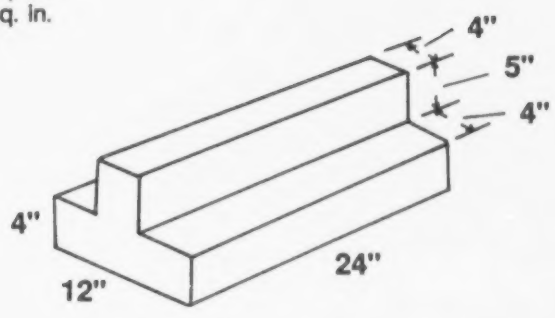
a. 168.00 sq. ft.
b. 1055.60 sq. ft.
c. 527.79 sq. ft.
d. 753.98 sq. ft.



Sphere

____ 8. Volume
- a. 576.00 cu. in
- b. 7,238.25 cu. in.
- c. 1,809.56 cu. in.
- d. 2,412.75 cu. in.

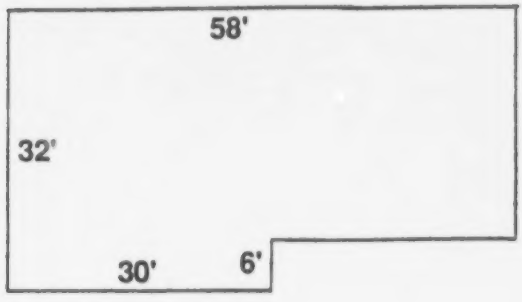
____ 9. Surface area
- a. 576.00 sq. in
- b. 7,238.25 sq. in.
- c. 1,809.56 sq. in.
- d. 2,412.75 sq. in.



____10. Volume
- a. 1,632 cu. in.
- b. 2,112 cu. in.
- c. 1,152 cu. in.
- d. 2,592 cu. in.

____11. Surface area
- a. 1,632 sq. in.
- b. 2,592 sq. in.
- c. 1,144 sq. in.
- d. 2728 sq. in.

Use the floor-plan drawing below to answer questions 12-14.

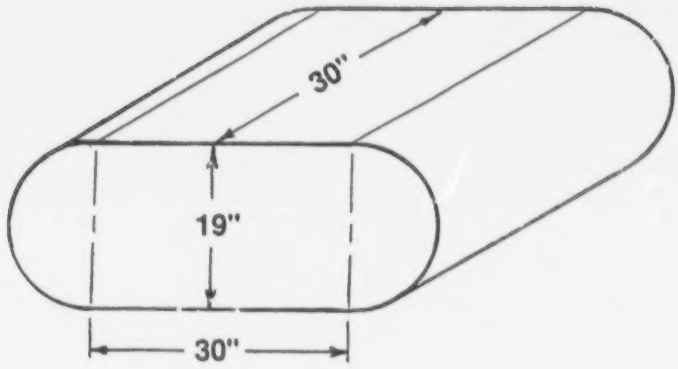


___12. How many square feet of floor space does this house contain?
- a. 1676 sq. ft.
- b. 1508 sq. ft.
- c. 1856 sq. ft.
- d. 1688 sq. ft.

___13. The basement floor will be poured 4" thick. How many cubic feet of concrete will be needed? (Round the answer to the nearest cubic foot.)
- a. 619 cu. ft.
- b. 563 cu. ft.
- c. 422 cu. ft.
- d. 559 cu. ft.

___14. There are 27 cubic feet in 1 cubic yard. Concrete is ordered by the cubic yard. How many cubic yards of concrete must be ordered to pour the floor? (Round the answer to the nearest cubic yard.)
- a. 21 cu. yd.
- b. 16 cu. yd.
- c. 33 cu. yd.
- d. 25 cu. yd.

Use the drawing of the tank below to answer questions 15 and 16.



____15. By finding the surface area of the tank, you can calculate the amount of steel required to build it. How many square inches of steel will be needed. (Round the answer to the nearest square inch.)

a. 2827 sq. in.
b. 2940 sq. in.
c. 5298 sq. in.
d. 5487 sq. in.

____16. What is the volume of the tank?

a. 25,606 cu. in.
b. 28,274 cu. in.
c. 17,100 cu. in.
d. 16,955 cu. in.

ANSWERS TO ASSIGNMENT SHEETS

AS 2.1

1. d (equilateral)
2. b (360)
3. d (50)
4. a (right)
5. c (140)
6. d (31.44")
7. b (41.95 sq. in.)
8. a (triangle)
9. d (A = L X W)
10. a (200 sq. in.)
11. d (429 sq. in.)
12. b (92.30 in.
13. c (obtuse
14. c (108)
15. c (224 sq. in.)
16. b (1,204 sq. ft.)
17. d (464 sq. ft.)
18. a (104.5 sq. cm.)
19. d (1,038 sq. ft.)

AS 2.2

1. a (3.1416)
2. d (circumference)
3. c (25.1328 in.)
4. a (36.1284 in.)
5. b (62.5 ft.)
6. d (145.3 sq. in.)
7. d (12 in.)
8. b (24 in.)
9. c (75.4 in.)
10. a (113.1 sq. in.)
11. b (452.4 sq. in.)
12. c (75)
13. a (210)
14. c (6 in.)
15. a (16 in.)

AS 2.3

1. b (512 cu. in.)
2. a (384 sq. in.)
3. d (cube)
4. b (15,468 sq. in.)
5. a (67,200 cu. in.)
6. a (1,583.37 cu. ft.)
7. d (753.98 sq. ft.)
8. b (7,238.25 cu. in.)
9. c (1,809.56 sq. in.)
10. a (1,632 sq. in.)
11. c (1,144 sq. in.)
12. d (1,688 sq. ft.)
13. b (563 sq. ft.)
14. a (21 cu. yd.)
15. c (5,298 sq. in.)
16. a (25,606 cu. in.)

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT II: GEOMETRIC FIGURES AND FORMS

UNIT TEST

Match terms on the right with definition

____ 1. Line connecting two points on the circumference of a circle

____ 2. Part of the circumference of a circle

____ 3. One angle of more than 90 degrees

____ 4. Line (distance) from center of a circle to the outside

____ 5. All sides unequal

____ 6. Contains one 90-degree angle

____ 7. Line connecting two points on the circumference of a circle through the center

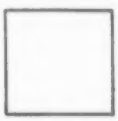
____ 8. All sides equal

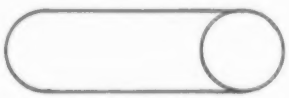
a. Chord
b. Radius
c. Right triangle
d. Equilateral
e. Diameter
ab. Arc
ac. Obtuse triangle
ad. Scalene triangle

Match the figures with the names

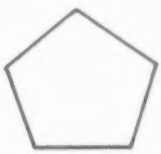
____ 9. Hexagon
____ 10. Cylinder
____ 11. Pentagon
____ 12. Parallelogram
____ 13. Square
____ 14. Rectangle
____ 15. Trapezoid
____ 16. Cube

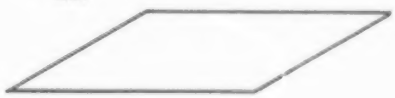
a.

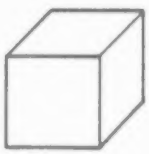
b. 

c. 

d.

e. 

ab. 

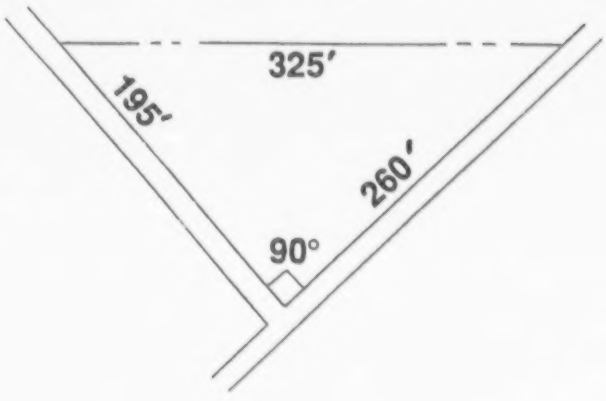
ac. 

ad.

Choose the best answer to each question

____17. What is the area of the triangular piece of land located between the two roads?

a. 24,700 sq. ft.
b. 31,687.5 sq. ft.
c. 25,350.0 sq. ft.
d. 22,650.0 sq. ft.



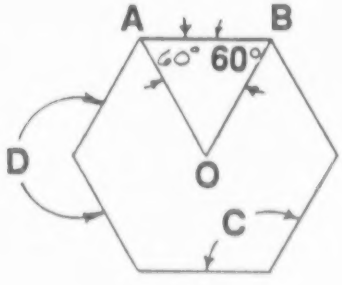
____18. What is the circumference of this circle?

a. 23.56 in.
b. 45.00 in.
c. 56.25 in.
d. 47.12 in.

____19. What angle is more than 90 degrees and less than 180.

a. straight
b. acute
c. reflex
d. obtuse

Use this figure to answer questions 20 - 22. All sides are the same length.



____20. How many degrees is angle C?

a. 125
b. 110
c. 120
d. 135

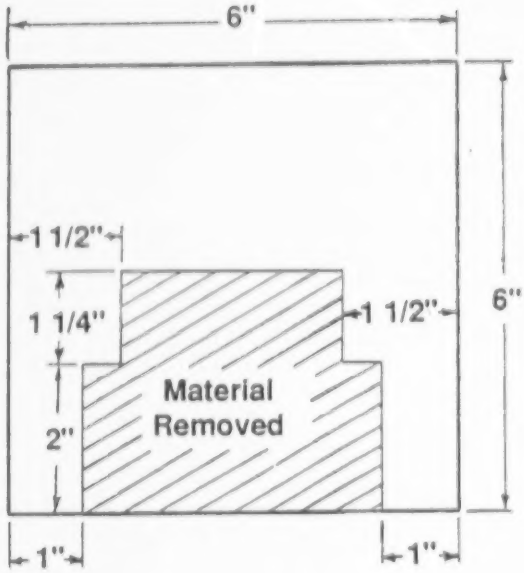
___21. What kind of triangle is AOB
- a. Obtuse
- b. Scalene
- c. Equilateral
- d. Right

___22. How many degrees is angle D?
- a. 240
- b. 225
- c. 250
- d. 235

___23. Which formula is used to find the area of a triangle?
- a. $A=1/2(b_1 \times b_2)$
- b. $A=bh$
- c. $A=L^2$
- d. $A=1/2bh$

___24. Rectangles made of sheet metal are 10 cm by 7 cm. In order to make six of these, how many square cm of sheet metal is needed?
- a. 480 sq. cm.
- b. 420 sq. cm.
- c. 360 sq. cm.
- d. 410 sq. cm.

Use the following drawing to answer questions 25 and 26.



___25. What is the total square inches of this piece of metal before being cut?
- a. 34 sq. in.
- b. 24 sq. in.
- c. 36 sq. in.
- d. 18 sq. in.

___26. How many square inches were cut away?
- a. 12 1/4 sq. in.
- b. 13 sq. in.
- c. 9 1/2 sq. in.
- d. 11 3/4 sq. in.

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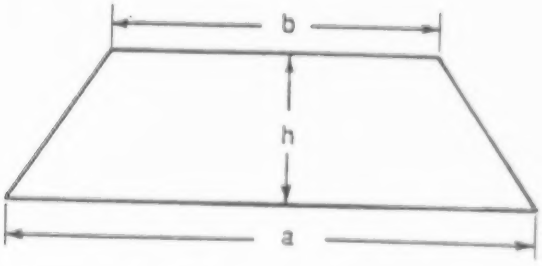
Round to the nearest thousandth where necessary.

____27. A piece of sheet metal measures 6 3/64" by 14 1/16". How many square inches does it have?
- a. 85.034 sq. in.
- b. 84.250 sq. in.
- c. 84.875 sq. in.
- d. 88.830 sq. in.

____28. A piece of sheet metal in the shape of a parallelogram is 35.9 cm high and 62.4 cm long. What is its area?
- a. 2,170.360 sq. cm.
- b. 2,246.400 sq. cm.
- c. 2,240.160 sq. cm.
- d. 2,059.200 sq. cm.

Determine the areas of each of the following trapezoids.

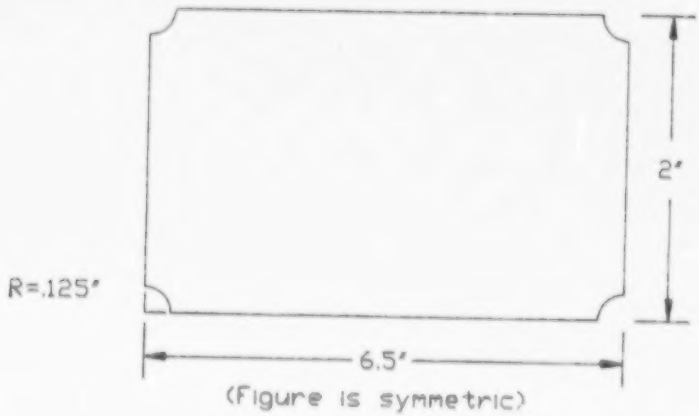


____29. a=5.699"; b=3.245"; h=1.34"
- a. 4.348 sq. in.
- b. 5.999 sq. in.
- c. 5.993 sq. in.
- d. 8.944 sq. in.

____30. a=3.211 m; b=1.97 m; h=0.5 m
- a. 1.295 sq. m.
- b. 0.9805 sq. m.
- c. 1.606 sq. m.
- d. 2.470 sq. m.

____31. a=405 mm; b=320 mm; h=422 mm
- a. 129,660 sq. mm.
- b. 135,040 sq. mm.
- c. 132,320 sq. mm.
- d. 152,975 sq. mm.

___32. What is the perimeter of the plate illustrated below?

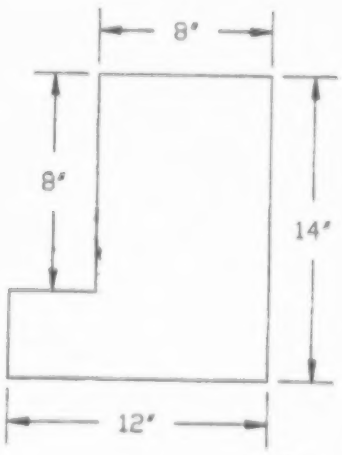


a. 16.500 in.
b. 17.750 in.
c. 16.785 in.
d. 17.000 in.

___33. A washer has an outside diameter of 350 mm and an inside diameter of 300 mm. What is the area of the washer?
a. 25,525.50 sq. mm.
b. 32,500.00 sq. mm.
c. 28,274.40 sq. mm.
d. 29,500.50 sq. mm.

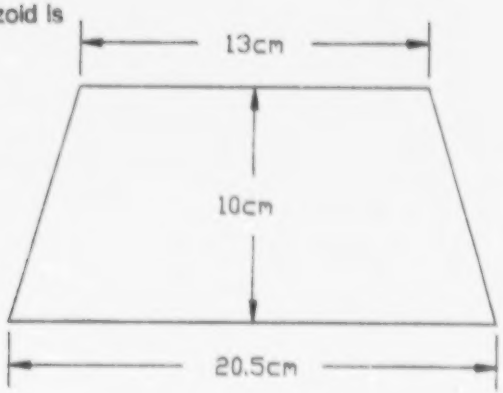
___34. Two triangles are cut from a 25 cm square piece of sheet metal. One has a base of 10 cm and an altitude of 5 cm. The other has a base of 10 cm and an altitude of 7 cm. How many square cm of sheet metal are left after these triangles are cut?
a. 60 cm^2
b. 600 mm.
c. 565 $cm.^2$
d. 625 $cm.^2$
e. 385 $cm.^2$

___35. The area of this plate is _____.



a. 136 $in.^2$
b. 130 $in.^2$
c. 28 $in.^2$
d. 168 $in.^2$
e. 14 $in.^2$

___36. The area of this trapezoid is



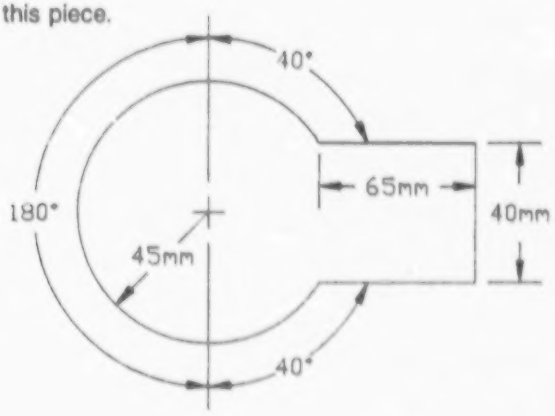
a. 43.5 cm^2
b. 53.5 cm^2
c. 167.5 $cm.^2$
d. 35 cm^2
e. 2665 $cm.^2$

___37. The area of a 12" grinding wheel with a 2" center hole is _____.
a. 31.416 $in.^2$
b. 109.956 $in.^2$
c. 439.823 $in.^2$
d. 452.39 $in.^2$
e. 13,975 $in.^2$

___38. The volume of a box measuring 4' by 3' by 2.5' is _____.
a. 30 $ft.^3$
b. 17.5 $ft.^3$
c. 24 $ft.^2$
d. 9.5 $ft.^3$
e. 19 $ft.^2$

___39. How many cubic mm of metal is removed by boring a hole 60 mm in diameter through a piece of steel 40 mm thick?
a. 2400 mm^3
b. 3769.9 $mm.^2$
c. 36,000 mm^3
d. 113,097.6 $mm.^3$
e. 144,000 mm^3

___40. Find the perimeter of this piece.



a. 311.4 mm.
b. 374.2 mm.
c. 412.7 mm.
d. 430 mm.
e. 452.7 mm.

____41. How much steel is needed to make an open cylinder 12" in length with a diameter of 6"?
- a. 72 $in.^2$
- b. 226.2 $in.^2$
- c. 113.1 $in.^3$
- d. 432 $in.^3$
- e. 864 $in.^3$

____42. An eight-sided figure is called_____.
- a. Pentagon
- b. Nonagon
- c. Heptagon
- d. Octagon
- e. Hexagon

____43. A shipper can accept boxes no higher than 6' and with a perimeter no greater than 16'. The box to be shipped is 4.75' high, 3.5'wide and 5.75' long. Will the shipper accept it? Show calculations.

- a. Yes
- b. No

What is the volume of spheres with the following diameters? (Round answers to the nearest ten-thousandth.)

____44. 12.75 mm.
- a. 1085.2510 cu. mm.
- b. 8681.9877 cu. mm.
- c. 361.7388 cu. mm.
- d. 868.1988 cu. mm.

____45. 6.232 cm
- a. 162.6839 cu. cm.
- b. 242.0373 cu. cm.
- c. 147.2168 cu. cm.
- d. 126.7307 cu. cm.

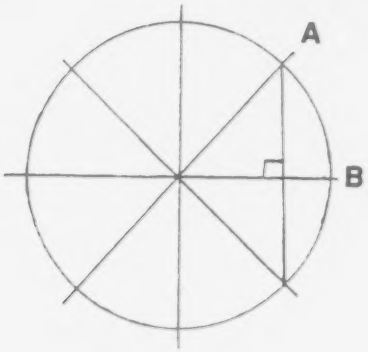
____46. 2.25"
- a. 3.7969 cu. in.
- b. 4.9268 cu. in.
- c. 5.9641 cu. in.
- d. 6.7513 cu. in.

____47. What is the volume of a box that is 4.5' wide, 6.75' long and 3' high?
- a. 86.10 cu. ft.
- b. 94.5 cu. ft.
- c. 86.0625 cu. ft.
- d. 91.125 cu. ft.

____48. How many cubic cm of steel are removed when a hole 3.54 cm in diameter is created in a 10-cm. block of steel which is 3 cm thick?

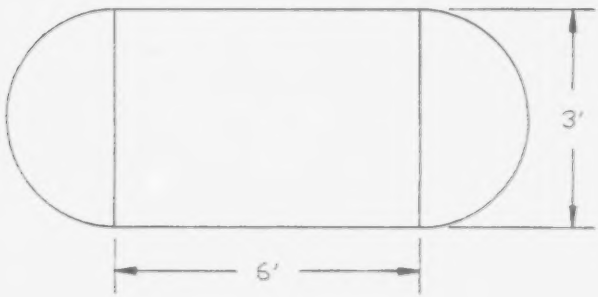
a. 33.3638 cu. cm.
b. 29.527 cu. cm.
c. 37.5948 cu. cm.
d. 31.86 cu. cm.

____49. How many degrees is arc AB?



a. 30
b. 40
c. 45
d. 50

____50. How many cubic feet of propane will this storage tank hold?



a. 48.9 cu. ft.
b. 42.4 cu. ft.
c. 56.5 cu. ft.
d. 61.26 cu. ft.

Match the angles on the right to the correct names.

____51. Reflex

____52. Obtuse

____53. Straight

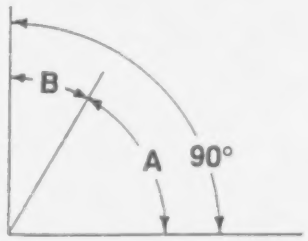
____54. Complementary

____55. Acute

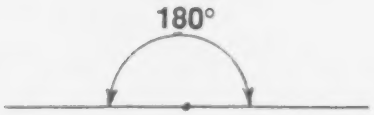
____56. Right

____57. Supplementary

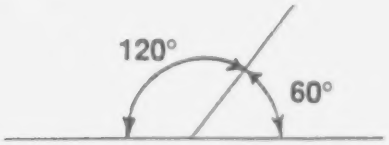
a.



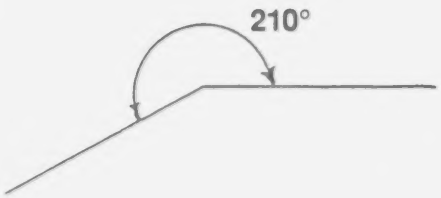
b.



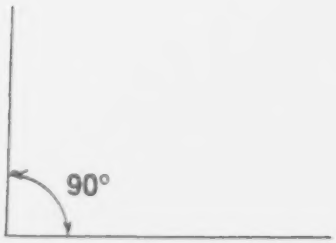
c.



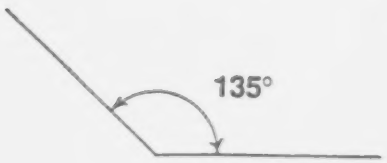
d.



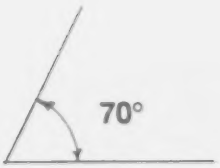
e.



ab.



ac.



ANSWERS TO UNIT TEST

1.	a
2.	ab
3.	ac
4.	b
5.	ad
6.	c
7.	e
8.	d
9.	ad
10.	c
11.	e
12.	ab
13.	b
14.	a
15.	d
16.	ac
17.	c
18.	d
19.	d
20.	c
21.	c
22.	a
23.	d
24.	b
25.	c
26.	d
27.	a
28.	c
29.	c
30	a
31.	d
32.	a
33.	a
34.	c
35.	a
36.	c
37.	b
38.	a
39.	d
40.	b
41.	b
42.	d
43.	b
44.	a
45.	d
46.	c
47.	d
48.	b
49.	c
50.	c
51.	d
52.	ab
53.	b
54.	a
55.	ac
56.	e
57.	c

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT III: RATIO AND PROPORTIONS

UNIT OBJECTIVE

Upon completion of this unit, the student should be able to use proportions to solve problems including those involving similar polygons. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring____percent on the unit test.

SPECIFIC OBJECTIVES

After completion of the lesson in this unit, the student should be able to:

1.1 Match ratio and proportion terms with definitions.

1.2 Identify and use ratios and proportions to solve common problems.

1.3 Apply proportions to the solution of problems involving similar polygons.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT III: RATIO AND PROPORTIONS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Lesson plan

1. Lesson 1: RATIO AND PROPORTIONS

a. Information outline

b. Assignment sheet

AS 1.1:Ratios and Proportions

c. Answers to assignment sheet

D. Unit Test

E. Answers to unit test

REFERENCES

A. Books

1. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

2. Boyce, John G., Samuel Slade and Louis Margolis. Mathematics for Technical and Vocational Schools. 6th ed. New York: Wiley and Sons, Inc., 1975.

3. Cleaves, Cheryl, Margie Hobbs, and Paul Dudenhefer. Basic Mathematics for Trades and Technologies. Englewood Cliffs, NJ: Prentice Hall, 1990.

4. Hoffman, Edward G., and Dennis D. Davis. Practical Problems in Mathematics for Machinists. 3rd ed. Albany, NY: Delmar Publishers, inc., 1988.

5. McCarthy, Willard J., and Victor E. Repp. Machine Tool Technology. Bloomington, IL: McKnight Publishing, Co., 1984.

B. Curriculum guide

1. Yettaw, Jerome. Vocational Machine Shop. University of Missouri-Columbia: Instructional Materials Laboratory, 1979.

C. Audiovisuals

1. Machine Shop Math (videotext, Machine Trades series). Edina, MN: Video Training Resource, Inc., 1980.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT III: RATIO AND PROPORTIONS

LESSON 1: RATIO AND PROPORTIONS

I. Terms and definitions

A. **Ratio**--a fixed relation in quantity or measure between two similar things. A ratio can be written as a fraction 4/1. It can also be written 4:1.

B. **Proportion**--a mathematical statement that shows two ratios or fractions

C. **Direct proportion**--a proportion in which the quantities being compared are directly related so that as one quantity increases (or decreases) the other quantity also increases (or decreases).

II. Ratios and proportions

A. Ratio

1. Comparison of one quantity to another quantity.

Example: The ratio of A to B might be expressed as A:B = 2:1. This means that A is twotimes as much as B.

B. Equations involving ratios and proportions are useful in solving many problems.

Example: The ratio 4:1 can also be written 16:4. Therefore, 4:1 = 16:4. This equation can also be written as 4/1 = 16/4. This relationship is a direct proportion.

C. Direct proportion equations can be used to solve problems involving ratios.

Example: If a machine shop can make 45 parts in three hours, how many can they make in five hours?

1. Step 1: Set up the proportion.

$$\frac{45 \text{ parts}}{3 \text{ hours}} = \frac{X \text{ parts}}{5 \text{ hours}}$$

or

$$\frac{3 \text{ hours}}{5 \text{ hours}} = \frac{45 \text{ parts}}{X \text{ parts}}$$

Note: Either equation gives the same answer. When setting up the equation, be sure that both sides are truly equal and that the units are equivalent.

2. Step 2: Cross-multiply to solve the equation. This means that you multiply the two known numbers (4 and 45) and divide by the other number (3). The answer is X.

$3X = 5 \times 45 = 225$

$X = 75$

D. Use proportions to convert fractions of degrees to minutes or seconds.

$$\frac{\text{1 degree}}{\text{60 minutes}} = \frac{\text{degrees expressed as a fraction}}{\text{X minutes}}$$

Example: How many minutes is 0.75°?

Solution: $\frac{1}{60} = \frac{.75}{X}$

or

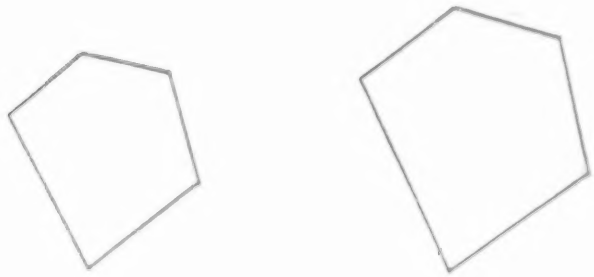
$X = 45'$

Seconds can be determined in the same way.

Note: To convert minutes and seconds to decimal degrees, divide the seconds by 60. Add the minutes. Then divide the minutes by 60 and add to the degrees.

III. Similar polygons

A. Similar polygons have corresponding angles that are equal and corresponding sides that are proportional.

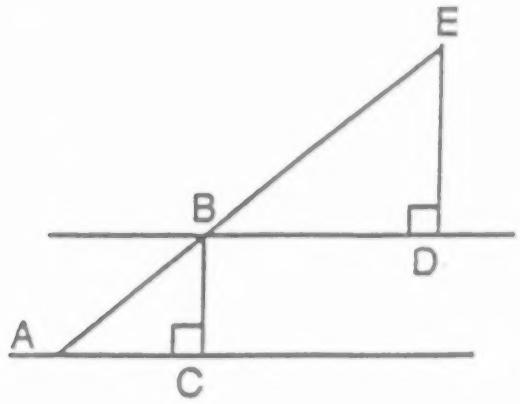


1. The ratio of any two corresponding sides is the same for all sides of similar polygons.

2. Perimeters of two similar polygons have the same ratio as any two corresponding sides.

3. The ratio of the areas of two similar polygons are the same as the ratios of the squares of any two corresponding sides or the ratios of the squares of their perimeters.

B. The general principles for similar polygons can be used with triangles to determine lengths and angles.

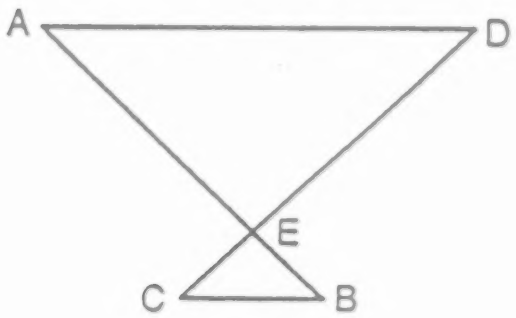


1. Since the corresponding angles in these right triangles are equal, these triangles are similar.

$$\frac{AB}{BE} = \frac{AC}{BD} = \frac{CB}{DE}$$

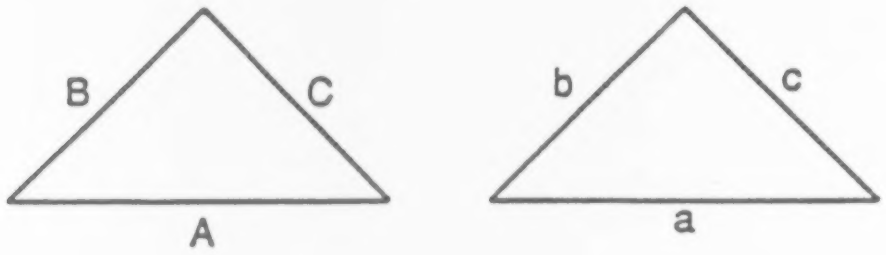
2. Thus, if you know the lengths of two of the sides of one triangle and one of the corresponding sides of the other triangle, you can solve the proportion for all other sides.

C. If AD and CB are parallel, triangles AED and CEB are similar and proportional.



RATIOS AND PROPORTIONS

The two triangles below are proportional to each other. **A:a = B:b = C:c**



1. A = 65 mm.; B = 55 mm.; b = 10 mm.; a = ____
2. C = 5.679 inches; A = 2.134 inches; c = 1.798 inches, a = ____
3. B = 6.5 cm.; C = 9.3 cm.; c = 7.2 cm.; b = ____
4. A truck travels 157.5 miles in three hours. If it maintains the same speed, how far will it travel in 4.5 hours?_____

Convert the following to degrees, minutes and seconds (to the nearest second).

5. 90.425° = _____
6. 45.892° = _____
7. 126.233° = _____

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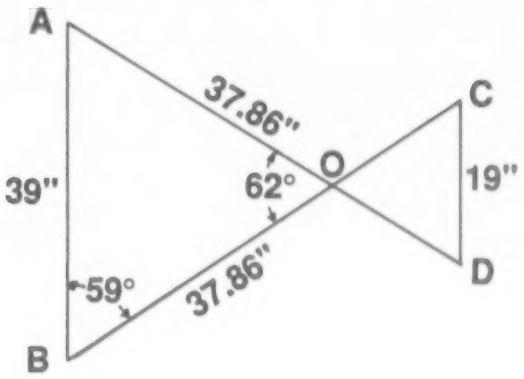
Use the drawing below to answer questions 8 and 9.



8. What is the length of line OD?_____

9. How many degrees is angle ODC?_____

10. What ratio is the same as 36 : 216?_____

a. 2:8
b. 2:9
c. 1:4
d. 1:6

ANSWERS TO AS 1.1

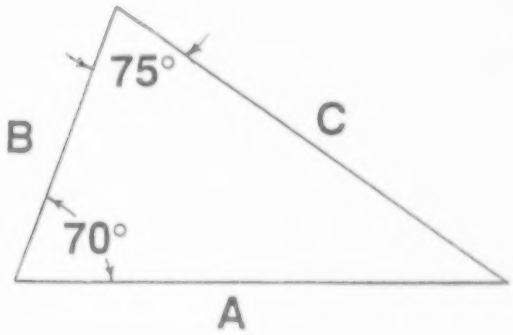
1. 11.8 mm.
2. 0.676 in.
3. 5.0 cm.
4. 236.25 miles
5. 90° 25' 30"
6. 45° 53' 31"
7. 126° 13' 59"
8. 18.44 in.
9. 59°
10. d (1:6)

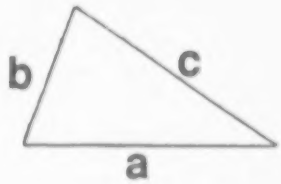
MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT III: RATIO AND PROPORTIONS

UNIT TEST

The two triangles below are proportional to each other. A:a = B:b = C:c. Find the unknown for questions 1-5.





1. A = 16.84 in.; B = 10 in.; b = 5 in. a = _____

2. A = 9.86 in.; C = 9.59 in.; a = 4.15 in. c = _____

3. B = 18.20 ft.; C = 29.82 ft.; c = 7.82 ft. b = _____

4. A = 70 mm.; B = 41.57 mm.; b = 5.94 mm. a = _____

5. A = 22.31 ft.; B = 13.25 ft.; C = 21.71 ft.; a = 7.44 ft. What is the perimeter of the small triangle abc? _____

____ 6. Which of the following can be reduced to the ratio of 5 to 7?

a. 120 to 161
b. 35 to 49
c. 125 to 170
d. 245 to 336

____ 7. To which of these can the ratio of 22 to 120 be reduced?

a. 4 to 7
b. 5 to 11
c. 2 to 3
d. 3 to 5

____ 8. Convert 75.21° to degrees, minutes and seconds. Which of the following is correct?

a. 75° 21' 00"
b. 75° 12' 36"
c. 75° 07' 25"
d. 75° 35' 00"

____ 9. If 3 gallons of paint covers 3,378 square feet, how many square feet will 5 1/4 gallons cover

a. 5,911.5 sq. ft.
b. 5,630.0 sq. ft.
c. 6,193.0 sq. ft.
d. 5,815.5 sq. ft.

____10. A train covers 150 1/2 miles in 3 1/2 hours. If the train continues at the same speed, how far will it travel in 5 hours and 15 minutes?

a. 215 1/4 miles
b. 221 1/2 miles
c. 236 1/2 miles
d. 225 3/4 miles

ANSWERS TO UNIT TEST

1. 8.42 in.
2. 4.04 in.
3. 4.77 ft.
4. 10.00 mm.
5. 19.10 ft.
6. b
7. d
8. b
9. a
10. d

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT IV: TRIGONOMETRIC FUNCTIONS

UNIT OBJECTIVES

Upon completion of this unit, the student should be able to define and use trigonometric functions and the Pythagorean Theorem, and solve problems with right and oblique triangles. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring____percent on the unit test.

SPECIFIC OBJECTIVES

After completion of the lesson in this unit, the student should be able to:

1.1 Match trigonometric terms with definitions.

1.2 Define the six trigonometric functions.

1.3 Determine the value of trigonometric functions using a calculator or table.

1.4 Solve for unknown parameters in right triangles using trigonometric functions.

1.5 Define and use the Pythagorean Theorem.

1.6 Solve for unknown parameters in oblique triangles.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT IV: TRIGONOMETRIC FUNCTIONS

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: RIGHT AND OBLIQUE TRIANGLES

a. Information outline

b. Handout

HO 1.1: Trigonometric functions
HO 1.2: Formula Variations

c. Assignment sheets

AS 1.1: Degrees and function values
AS 1.2: Dimensions and angles of right triangles
AS 1.3: Dimensions and angles of oblique triangles

d: Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

A. Books

1. Baril, Richard. Modern Machining Technology. Albany, NY: Delmar Publishers, Inc., 1987.

2. Boyce, John G., Samuel Slade and Louis Margolis. Mathematics for Technical and Vocational Schools. 6th ed. New York: Wiley and Sons, Inc., 1975.

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Materials Laboratory, 1979.

C. Audiovisuals

1. Machine Shop Math (videotext, Machine Trades series). Edina, MN: Video Training Resource, Inc., 1980.

NOTES TO INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Trigonometric functions and applications have been presented in this unit without proofs. The instructor may wish to illustrate the proof of the trigonometric ratios to show how trigonometry develops naturally from geometry axioms and theorems.

MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT IV: TRIGONOMETRIC FUNCTIONS

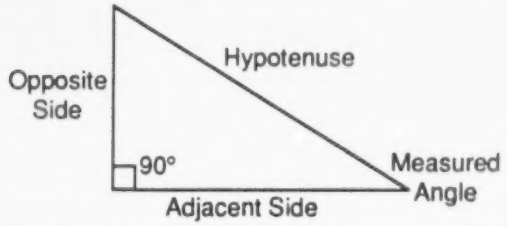
LESSON 1: RIGHT AND OBLIQUE TRIANGLES

I. Terms and definitions

A. **Adjacent side**--side of a right triangle which is next to the measured angle

B. **Hypotenuse**--right triangle side which is opposite the right angle, also the longest side

C. **Opposite side**--side of a right triangle which is opposite or across from the measured angle



D. **Right triangle**--three-sided figure that has a right angle (90°)

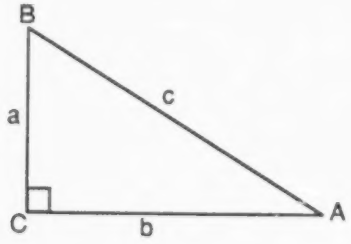
E. **Trigonometry**--study of the trigonometric functions which express the relationships between the sides and angles of right triangles

II. Triangle identification

A. Angles are represented by capitalized letters: A, B, and C.

B. Sides are represented by lower-case letters: a, b, and c (c represents the hypotenuse).

C. Similarly labeled side and angle are opposite.



III. Definition of trigonometric functions

A. Six functions are used in right triangle trigonometry.

1. Functions are the ratios between the various sides of a right triangle.

2. Trigonometric functions are very valuable because if you know two dimensions of a right triangle, you can determine all the other dimensions.

3. Trigonometric functions are ratios that are the same for a given angle for all triangles. You can find values of trigonometric functions in trigonometric tables.

B. Definitions

		Abbreviated Form
1. Sine (sin)		
Sine of an angle =	$\frac{\text{length of the opposite side}}{\text{length of the hypotenuse}}$	$\sin = \frac{\text{opp}}{\text{hyp}}$
2. Cosine (cos)		
Cosine of an angle =	$\frac{\text{length of adjacent side}}{\text{length of hypotenuse}}$	$\cos = \frac{\text{adj}}{\text{hyp}}$
3. Tangent (tan)		
Tangent of an angle =	$\frac{\text{length of opposite side}}{\text{length of adjacent side}}$	$\tan = \frac{\text{opp}}{\text{adj}}$
4. Cotangent (cot)		
Cotangent of an angle =	$\frac{\text{length of adjacent side}}{\text{length of opposite side}}$	$\cot = \frac{\text{adj}}{\text{opp}}$
5. Secant (sec)		
Secant of an angle =	$\frac{\text{length of hypotenuse}}{\text{length of adjacent side}}$	$\sec = \frac{\text{hyp}}{\text{adj}}$
6. Cosecant (csc)		
Cosecant of an angle =	$\frac{\text{length of hypotenuse}}{\text{length of opposite side}}$	$\csc = \frac{\text{hyp}}{\text{opp}}$

NOTE: Tan and cot are reciprocals, sin and csc are reciprocals, and cos and sec are reciprocals. The reciprocal of any number is 1 divided by that number. Example: The reciprocal of 24 is 1/24.

IV. Determining the value of trigonometric functions

A. Scientific calculators can compute trigonometric functions.

1. Calculators save time and reduce errors.

2. Enter the angle in decimal degrees, then press the desired function key.

B. You can also find trigonometric functions in trigonometric tables. Most tables give values to four decimal places. Most values are irrational numbers and are nonrepeating, nonterminating decimals. (HO 1.1)

V. Solution of right angle triangles (HO 1.2)

A. Finding the length of the side opposite a known angle

1. When you know the length of the hypotenuse,

a. Multiply the hypotenuse by the sine of the angle.

b. Or divide the hypotenuse by the cosecant of the angle.

2. When you know the length of the side adjacent,

a. Multiply the side adjacent by the tangent of the angle.

b. Or divide the side adjacent by the cotangent of the angle.

B. To find the length of the side adjacent to a known angle,

1. When you know the length of the hypotenuse,

a. Multiply the hypotenuse by the cosine of the angle.

b. Or divide the hypotenuse by the secant of the angle.

2. When you know the length of the side opposite,

a. Multiply the side opposite by the cotangent of the angle.

b. Or divide the side opposite by the tangent of the angle.

C. To find the length of the hypotenuse,

1. When you know the length of the side opposite the angle,

a. Multiply the side opposite by the cosecant of the angle.

b. Or divide the side opposite by the sine of the angle.

2. When you know the length of the side adjacent the angle,

a. Multiply the side adjacent by the secant of the angle.

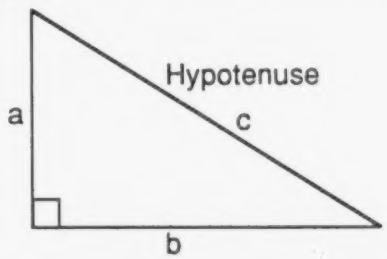
b. Divide the side adjacent by the cosine of the angle.

VI. Pythagorean Theorem

A. The Pythagorean Theorem is used to find a side when the other two sides of a right triangle are known.

B. In any right angle triangle, the square of the hypotenuse equals the sum of the squares of the other two sides.

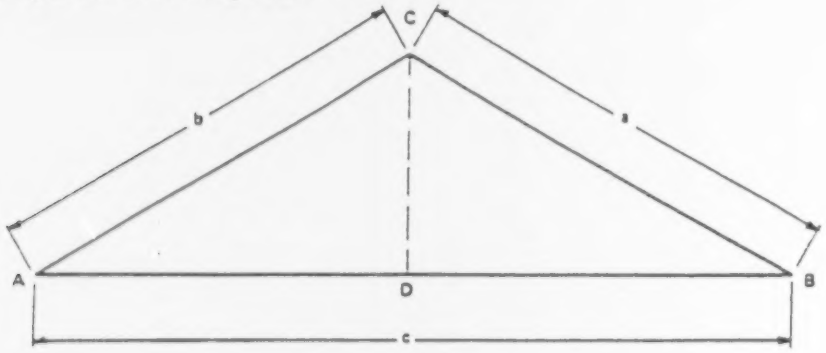
$c^2 = a^2 + b^2$



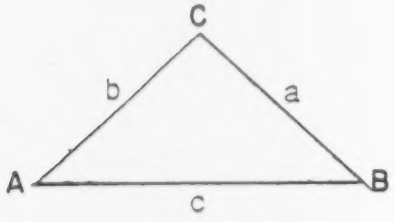
C. By rearranging the formula, $a^2 = c^2 - b^2$ and $b^2 = c^2 - a^2$.

VII. Solving oblique triangles, which contain no right angles (HO 1.2)

A. Dimensions of oblique triangles are determined by drawing perpendicular lines to make right triangles and then using ratios.



B. The law of sines: The sides and angles of any triangle can be determined if two sides and an opposite angle or two angles and an opposite side are known.



$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \quad \text{or}$$

$$\frac{\sin A}{\sin B} = \frac{a}{b} \qquad \frac{\sin A}{\sin C} = \frac{a}{c} \qquad \frac{\sin B}{\sin C} = \frac{b}{c}$$

C. Law of cosines: In any triangle, the square of any side is equal to the sum of the squares of the other two sides minus twice the product of these sides and the cosine of the angle included between them.

1. $a^2 = b^2 + c^2 - 2bc(\cos A)$ or $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

2. $b^2 = a^2 + c^2 - 2ac(\cos B)$ or $\cos B = \frac{a^2 + c^2 - b^2}{2ac}$

3. $c^2 = a^2 + b^2 - 2ab(\cos C)$ or $\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

D. The sides and angles of any triangle can be determined if any three parts (angles or sides) are known.

1. Two angles and one side are known.

   a. The third angle can be determined by using the fact that the sum of the angles is 180°.

   b. Use the law of sines to find each of the remaining sides.

2. Two sides and the angle opposite one of them are known.

   a. Use the law of sines to find the unknown angle opposite a given side.

   b. Find the third angle by subtraction from 180°.

   c. Find the third side by using the law of sines again.

   NOTE: Under certain conditions, two distinct triangles (two solutions) can exist with the same three given parts.

3. Two sides and the included angle are known.

   a. Use the law of cosines to find the third side.

   b. Find the second angle using the law of sines and the third by subtraction.

4. The three sides are known.

   a. Use the law of cosines to find each of the angles.

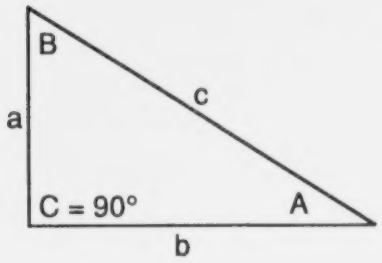
   b. As a check, add the degrees of all of the angles. (The sum should be 180°.)

TRIGONOMETRIC FUNCTIONS

∞ = Infinity

DEGREE	SIN	COS	TAN	COT	SEC	CSC
0	0	1	0	∞	1	∞
30	.50000	.86603	.57735	1.73205	1.154701	2
45	.707107	.707107	1	1	1.414214	1.414214
60	.86603	.50000	1.73205	.57735	2	1.154701
910	1	0	∞	0	∞	1
120	.86603	-.50000	-1.73205	-.57735	-2	1.154701
150	.50000	-.86603	-.57735	-.1.73205	-1.154701	2
180	0	-1	0	∞	-1	∞
210	-.50000	-.86603	-.57735	1.73205	-1.154701	-2
240	-.86603	-.50000	1.73205	.57735	-2	-1.154701
270	-1	0	∞	0	∞	-1
300	-.86603	.50000	-1.73205	-.57735	2	-1.15470
330	-.50000	.86603	-.57735	-1.73205	1.15470	-2
360	0	1	0	∞	1	∞

RIGHT TRIANGLES

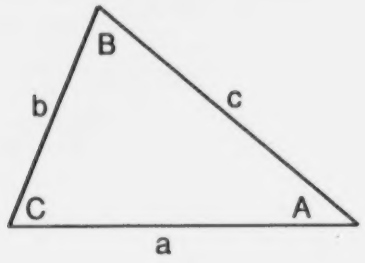


FORMULAS FOR FINDING FUNCTIONS OF ANGLES	
SINE = Side opposite/Hypotenuse	COTANGENT = Side adjacent/Side opposite
COSINE = Side adjacent/Hypotenuse	SECANT = Hypotenuse/Side adjacent
TANGENT = Side opposite/Side adjacent	COSECANT = Hypotenuse/Side opposite

TO FIND ANGLES	FORMULAS	
C	a/a = Sine C	90° - B
C	b/a = Cosine C	90° - B
C	a/b = Tan C	90° - B
C	b/a = Cotan. C	90° - B
C	a/b = Secant C	90° - B
C	a/c = Cosec. C	90° - B
B	b/a = Sine B	90° - C
B	a/a = Cosine B	90° - C
B	b/a = Tan B	90° - C
B	a/b = Cotan. B	90° - C
B	a/c = Secant B	90° - C
B	a/b = Cosec. B.	90° - C

TO FIND SIDES	FORMULAS	
a	$\sqrt{b^2 + c^2}$	
a	c x Cosec. C	c/Sine C
a	c x Secant B	c/Cosine B
a	b x Cosec. B	b/Sine B
a	b x Secant C	b/Cosine C
b	$\sqrt{a^2 - c^2}$	
b	a x Sine B	a/Cosecant B
b	a x Cos. C	a/Secant C
b	c x Tan. B	c/Cotangent B
b	c x Cot. C	c/Tangent C
c	$\sqrt{a^2 - b^2}$	
c	a x Cos. B	a/Secant C
c	a x Sine C	a/Cosecant C
c	b x Cot. B	b/Tangent B
c	b x Tan C	b/Cotangent C

OBLIQUE TRIANGLES



LAW OF SINES
a/Sin. A = b/Sin. B = c/Sin. C

LAW OF COSINES	
Cos A = (b2 + c2 - a2)/2bc	$a^2 = b^2 + c^2 - 2bc(\text{Cos A})$
Cos B = (a2 + c2 + b2)/2ac	$b^2 = a^2 + c^2 - 2ac(\text{Cos B})$
Cos C = (a2 + b2 - c2)/2ab	$c^2 = a^2 + b^2 - 2ab(\text{Cos C})$

Note: Law of Sines and Law of Cosines will work for any triangle

TO FIND	KNOWN	SOLUTION
C	A - B	180° - (A +B)
b	a - B - A	a x Sin. B/Sin. A
c	a - A - C	a x Sin. C/Sin. A
Tan. A	a - C - b	a x Sin. C/(b - (a x Cos. C))
B	A - C	180° - (A + C)
Sin. B	b - A - a	b x Sin. A/a
A	B - C	180° - (B + C)
Cos. A	a -b - c	(b2 + c2 - a2)/2bc
Sin. C	c - A - a	c x Sin. A/a
Cot. B	a - C - b	a x csc C/(b - Cot. C)
c	b - C - B	b x Sin. C x csc B

HO 1.2

DEGREES AND FUNCTION VALUES

Determine the following functions (to the nearest 5 places).

1. Sine of 35° 24' 32" _____
2. Tangent of 47° 30' 45" _____
3. Cosine of 65° 00' 35" _____
4. Tangent 50° 40' 15" _____
5. Sine 83° 45' _____
6. Sine 25° 26' _____

Determine the angles corresponding to each of the following values (Deg.° M' S")

7. cos Y = 0.99182 _____
8. tan Y = 0.50587 _____
9. sin Y = 0.82577 _____
10. tan Y = 0.08163 _____
11. cos Y = 0.81111 _____

Determine the sine, cosine and tangent of the following angles (to the nearest 5 places).

		Sine	Cosine	Tangent
12.	130°	_____	_____	_____
13.	125° 49' 15"	_____	_____	_____
14.	170° 45'	_____	_____	_____

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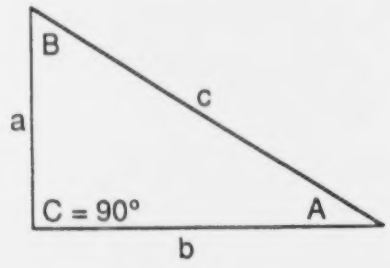
DIMENSIONS AND ANGLES OF RIGHT TRIANGLES

1. If a right triangle has a 35° angle, how many degrees is is the third angle?

Using the information given, determine the length of the third side.



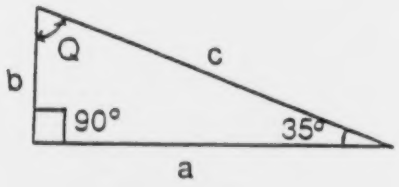
2. a = 45 mm; b = 12 mm _____

3. a = 1.3 yards; c = 4.67 yards _____

4. b = 6.234"; c = 9.345" _____

5. c = 205 mm; a = 187 mm _____

Use the figure below to answer the following questions.

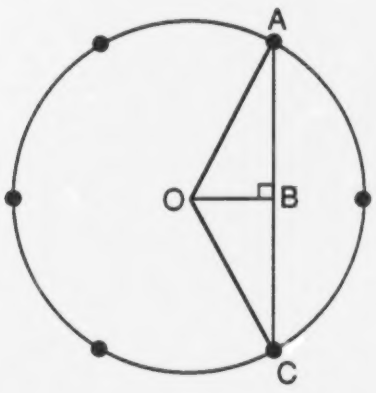


6. How many degrees is angle Q? _____

7. If side c = 10", what is the length of side b? _____
   What is the length of side a? _____

8. If side b = 4.5", what is the length of side c? _____
   What is the length of side a? _____

Six holes are equally spaced around a 100 mm circle. Answer the questions that follow.



9. What size is angle AOC in degrees? _____

10. What size is angle AOB? _____

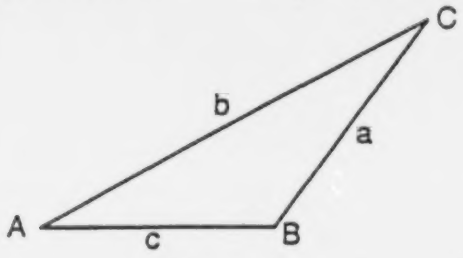
11. What is the length of line OA?_____

12. What is the length of line OB?_____

13. What is the length of line AC?_____

DIMENSIONS AND ANGLES OF OBLIQUE TRIANGLES

Using the laws of sines and/or cosines and the values given, find the missing values in the triangle below.



1. Side a = 45 mm, angle A = 43° and angle B = 100°. Find side b, side c and angle C.

   b = _____ c = _____ C = _____

2. Side b = 85.4 mm, angle A = 37° and angle C = 35°. Find side a, side c and angle B.

   a = _____ c = _____ B = _____

3. Angle A = 32°, angle C = 46° and side c = 15 mm. Find sides a and b and angle B.

   a = _____ b = _____ B = _____

4. Angle C = 28°, side c = 19 mm and side b = 22 mm. Find side a and angles A and B.

   a = _____ A = _____ B = _____

5. Angle B = 97°, side a = 36 mm and side c = 41 mm. Find side b and angles A and C.

   b = _____ A = _____ C = _____

6. Side a = 238 mm, side b = 327 mm and side c = 190 mm. Find all of the angles.

   A = _____ B = _____ C = _____

ANSWERS TO AS 1.1

1. 0.57941
2. 1.0918
3. 0.42246
4. 1.22049
5. 0.99406
6. 0.42946
7. 7°20'
8. 26°50'
9. 55°40'
10. 4°40'
11. 35°47'44"
12. 0.76604, -0.64279, -1.1918
13. 0.81085, -0.58525, -1.38547
14. 0.16074, -0.98700, -0.16286

ANSWERS TO AS 1.2

1. 55°
2. C = 46.6 mm
3. B = 4.5 yards
4. A = 6.962"
5. B = 84 mm
6. a. 55°
7. B = 5.7", A 8.2"
8. C = 7.8", A = 6.4"
9. 120°
10. 60°
11. 50 mm
12. 25 mm
13. 86.6 mm

ANSWERS TO AS 1.3

1. b = 65 mm, c = 40 mm, Angle C = 37°
2. a = 54.0 mm, c = 51.5 mm, Angle b = 108°
3. a = 11 mm, b = 20 mm, Angle B = 102°
4. a = 3.5 mm or 35 mm, Angle A = 5° or 119°, Angle B = 33° or 147°
5. b = 58 mm, Angle A = 38°, Angle C = 45°
6. Angle A = 46°, Angle B = 99°, Angle C = 35°

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MODULE: PERFORMING MATHEMATICAL CALCULATIONS

UNIT IV: TRIGONOMETRIC FUNCTIONS

UNIT TEST

NOTE: A trigonometric table or calculator with trigonometric functions will be needed to complete this test.

Match definitions on the left with terms on the right.

____	1.	The side opposite the right angle	a. Pythagorean
____	2.	Ratio of the side opposite an angle to the hypotenuse of a right triangle	b. Tangent
____	3.	Ratio of the side opposite an angle to the side adjacent an angle in a right triangle	c. Secant
____	4.	Ratio of the side adjacent an angle to the hypotenuse in a right triangle	d. Cosine
____	5.	Inverse of the cosine function	e. Law of sines
____	6.	Inverse of the sine function	ab. Law of cosines
____	7.	Used to find the side of a right triangle when the other two sides are known	ac. Hypotenuse
____	8.	The ratios of sides to sines of opposite angles are proportional in any triangle	ad. Cosecant
____	9.	Used to find a side of any triangle when two sides and the included angle are known	ae. Sine

Choose the best answer to each question or problem.

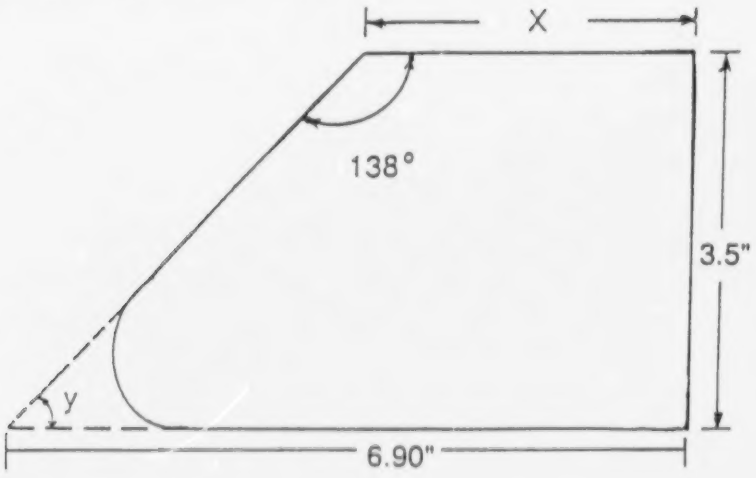
____ 10. If the hypotenuse of a right triangle is 9 cm and one of the sides is 4 cm, how long is the third side?

a. 2.24 cm
b. 3.61 cm
c. 8.06 cm
d. 9.85 cm
e. 65 cm

____ 11. How long is the hypotenuse of a right triangle which has sides that are 5" and 7"?

a. 4.9"
b. 6"
c. 8.6"
d. 65"
e. 74"

Use the following diagram for questions 12 and 13.



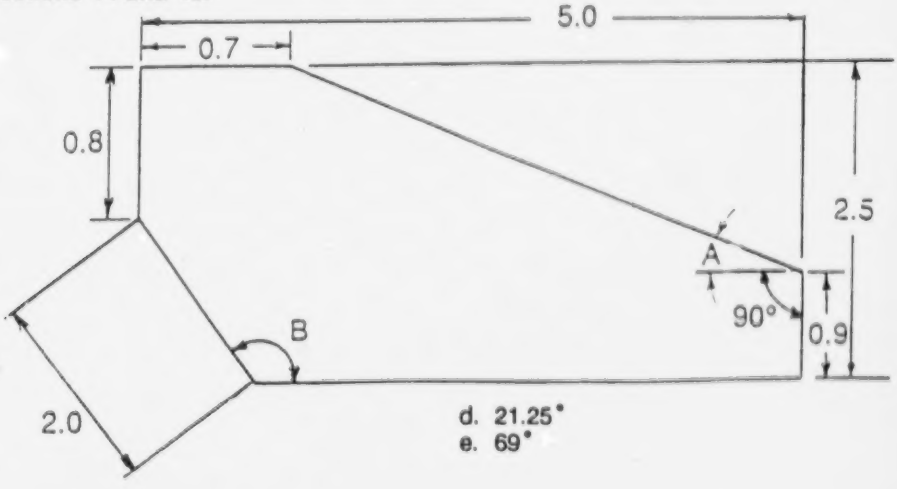
___ 12. Determine angle y.

a. 15°
b. 30°
c. 32°
d. 42°
e. 52°

___ 13. Determine distance x.

a. 3.06
b. 3.89
c. 4.00
d. 4.25
e. 4.31

Use the following diagram for questions 14 and 15.



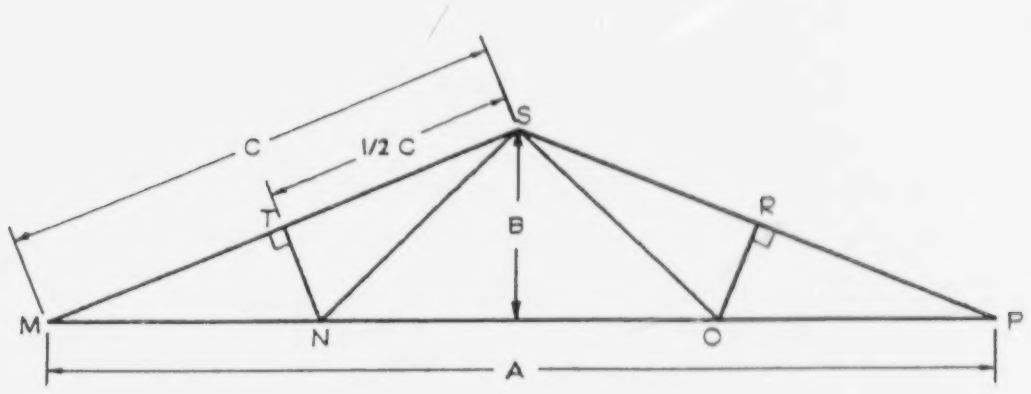
___ 14. Determine angle A.

a. 17.75°
b. 18.75°
c. 20.41°
d. 21.25°
e. 69°

___ 15. Determine angle B.

a. 131.46°
b. 118.25°
c. 119.52°
d. 110.58°
e. 82.5°

Use the following drawing for questions 16-19.



GIVEN: A = 30' B = 6' MS = SP Truss is symetrical

___ 16. What is the length of MS?

a. 13.75'
b. 16.16'
c. 15.00'
d. 16.60'

___ 17. What is the length of TN?

a. 3.23'
b. 3.37'
c. 2.96'
d. 2.23'

___ 18. What is the length of SO?

a. 8.15'
b. 8.08'
c. 8.70'
d. 9.02'

___ 19. What is the length of MN?

a. 9.02'
b. 7.91'
c. 8.70'
d. 8.08'

ANSWERS TO UNIT TEST

1. ac
2. ae
3. b
4. d
5. c
6. ad
7. a
8. e
9. ab
10. c
11. c
12. d
13. a
14. c
15. e
16. b
17. a
18. c
19. c